Learning objectives

The aim of this study was:

- To compare the efficacy of thyroid nodules evaluation systems: TIRADS and FNA guidelines, by radiologists in training.
- To review the TIRADS System (Thyroid Imaging Reporting and Data System), which is used as a predictor of malignancy.
- To review the suspicious for malignancy US features, leading to FNA (Fine Needle Aspiration).
- To provide an overview of the current classification schemes for cytologic diagnosis.

Background

Thyroid nodules are a very frequent pathology of the adult population and consists a significant part of the daily practice of a radiology department. Although there is a high prevalence of thyroid nodules, most of them are benign.

There are several published studies and guidelines trying to standardise suspicious US characteristics that refer to malignancy, but FNA still provides the final diagnosis and management planning.

There is the need, especially for the less experienced junior doctors, to identify and comprehend the US features of nodules, learn and act according the guidelines of evaluation of thyroid nodules and perform FNA successfully when needed.

Imaging findings OR Procedure details

In this study four radiologists in training evaluated separately, US findings of thyroid nodules aspirated from September to December 2011, by using two classification methods:

- The TIRADS "Thyroid Imaging Reporting and Data System" (table 1).
- The Guidelines for thyroid nodules FNA indications and management (table 2).
Table 1

**TIRADS**\(^{(1)}\)

This classification system was created from the need for a cost / effective management and limitation of unnecessary FNA procedures when possible.

Correlates number of suspicious US findings with the risk of malignancy, so that each category reflects a percentage of malignancy similar to those accepted in the BI-RADS (Breast Imaging Reporting and Data System).

<table>
<thead>
<tr>
<th>Category</th>
<th>US suspicious features</th>
<th>Suspicion for Malignancy</th>
<th>Risk of Malignancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>normal parenchyma</td>
<td>negative</td>
<td>0 %</td>
</tr>
<tr>
<td>2</td>
<td>none (colloid cyst)</td>
<td>benign</td>
<td>0 %</td>
</tr>
<tr>
<td>3</td>
<td>none</td>
<td>probably benign</td>
<td>1.7 %</td>
</tr>
<tr>
<td>4a</td>
<td>one</td>
<td>low</td>
<td>3.3 %</td>
</tr>
<tr>
<td>4b</td>
<td>two</td>
<td>intermediate</td>
<td>9.2 %</td>
</tr>
<tr>
<td>4c</td>
<td>three or four</td>
<td>moderate</td>
<td>44.4 - 72.4 %</td>
</tr>
<tr>
<td>5</td>
<td>five</td>
<td>High</td>
<td>87.5 %</td>
</tr>
</tbody>
</table>

Table 2

**Indications for FNA Biopsy**

**TIRADS 2011**\(^{(1)}\)

**AACE/AME/ETA 2010**\(^{(3)}\)

Category 4a (optional), 4b, 4c, 5

- Of diameter larger than 1.0 cm that is solid and hypoechoic on US.
- Of any size with US findings suggestive of extracapsular growth or metastatic cervical lymph nodes.
- Of any size with patient history of neck irradiation in childhood or adolescence; PTC, MTC, or MEN 2 in first-degree relatives; previous thyroid surgery for cancer; increased calcitonin levels in the absence of interfering factors.
• Of diameter smaller than 10 mm along with US findings associated with malignancy.
• High-risk history nodule with suspicious sonographic features >5mm.
• High-risk history nodule without suspicious sonographic features >5mm.
• Abnormal cervical lymph nodes.
• Microcalcifications present in nodule #1 cm.
• Solid nodule and hypoechoic >1 cm.
• Solid nodule and iso- or hyperechoic # 1-1.5 cm.
• Mixed cystic-solid nodule with any suspicious ultrasound features 1.5-2.0 cm.
• Mixed cystic-solid nodule without suspicious ultrasound features # 2.0 cm.
• Spongiform nodule # 2.0 cm.
• Purely cystic nodule FNA not indicated.

Society of Radiologists in Ultrasound Consensus

2005

• Solitary nodule with microcalcifications # 1 cm.
• Solid (or almost entirely solid) or coarse calcifications # 1.5 cm.
• Mixed solid and cystic or almost entirely cystic with solid mural component # 2 cm.
• None of the above but substantial growth since prior US examination.
• Almost entirely cystic and none of the above and no substantial growth FNA probably unnecessary.
• In multiple nodules consider FNA of one or more nodules, on basis of criteria.
Table A contains classification results and the average distribution of nodules.

Table A

<table>
<thead>
<tr>
<th>Thyroid Nodules Evaluation</th>
<th>Classification Method</th>
<th>Radiologists in Training</th>
<th>mean</th>
<th>distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>TIRADS</td>
<td>2</td>
<td>0 %</td>
<td>4 %</td>
<td>6,6%</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>0 %</td>
<td>0 %</td>
<td>1,3%</td>
</tr>
<tr>
<td>4a</td>
<td></td>
<td>40,8%</td>
<td>32,9%</td>
<td>44,7%</td>
</tr>
<tr>
<td>4b</td>
<td></td>
<td>47,4%</td>
<td>38,1%</td>
<td>42,1%</td>
</tr>
<tr>
<td>4c</td>
<td></td>
<td>11,8%</td>
<td>25%</td>
<td>5,3%</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>0 %</td>
<td>0 %</td>
<td>0 %</td>
</tr>
<tr>
<td>FNA Guidelines</td>
<td>Suspicious</td>
<td>100%</td>
<td>98,7%</td>
<td>93,4%</td>
</tr>
<tr>
<td></td>
<td>Non suspicious</td>
<td>0 %</td>
<td>1,3%</td>
<td>6,6%</td>
</tr>
</tbody>
</table>

Results between the two methods were similar (Table B):

Table B

<table>
<thead>
<tr>
<th>FNA Indicated</th>
<th>TIRADS</th>
<th>FNA Guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indicated</td>
<td>97 %</td>
<td>97,3 %</td>
</tr>
<tr>
<td>Non indicated</td>
<td>3 %</td>
<td>2,7 %</td>
</tr>
</tbody>
</table>

The radiologists who performed the US guided FNA, were trained for one to two months and were the same who made the US evaluation.

According to the suspicious US findings (table 3) and FNA indications (table 2) **US guided FNA** was performed in thyroid nodules:

A. TIRADS categories: 4a, 4b, 4c, 5.

B. #1cm or <1cm with suspicious US features.
C. Purely cystic nodules were excluded.

Table 3

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sensitivity (%) (10)</td>
</tr>
<tr>
<td>Solid component</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>69.0-75.0</td>
</tr>
<tr>
<td>Hypoechogenicity</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>26.5-87.1</td>
</tr>
<tr>
<td>Margins microlobulated, irregular or infiltrative</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>17.4-77.5</td>
</tr>
<tr>
<td>Absent halo</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>17.4-77.5</td>
</tr>
<tr>
<td>Microcalcifications</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>26.1-59.1</td>
</tr>
<tr>
<td>Taller-than-wide shape</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>32.7</td>
</tr>
<tr>
<td>Increased nodular vascularity (chaotic)</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>54.3-74.2</td>
</tr>
</tbody>
</table>

Cytologic evaluation (table c) was based on a modification of the British Thyroid Association (BTA)/Royal College of Physicians classification scheme (5) and our results were very close to the range published for the cytologic distribution of nodules (table 4):

Table C

<table>
<thead>
<tr>
<th>RCPath (BTA)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Thy 1</td>
<td>18,4 %</td>
</tr>
<tr>
<td>Thy 2</td>
<td>39,5 %</td>
</tr>
<tr>
<td>Thy 2c</td>
<td>36,8 %</td>
</tr>
<tr>
<td>Thy 3a</td>
<td>2,6 %</td>
</tr>
</tbody>
</table>
Thy 3f  1,3 %
Thy 4  1,3 %
Thy 5  0 %

- Thy1: (non-diagnostic/inadequate sample) is comparable to literature range 10-20%. FNA was repeated in most cases. Presence of cytologist during the procedure reduces the inadequate samples.
- Thy2 & 2c: most nodules had one or two US suspicious findings, so classified as TIRADS 4a and 4B.
- Thy3a: nodules were classified from all radiologists as TIRADS 4c, except one classified as 4a.
- Thy3f & Thy4: all nodules were classified as TIRADS 4c.

Table 4
Classification Schemes for Cytologic Diagnosis Thyroid FNA Biopsy

<table>
<thead>
<tr>
<th>AACE/AME/ATA 2010 (3)</th>
<th>Revised ATA 2009 (4)</th>
<th>RCPath (BTA) 2009 (5)</th>
<th>NCI (Bethesda) 2009 (6)</th>
<th>Result distribution</th>
<th>Risk of malignancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1 - Category 1 - Thy1 - I -</td>
<td></td>
<td></td>
<td></td>
<td>10% - 15%</td>
<td>0 - 10 %</td>
</tr>
<tr>
<td>Nondiagnostic or inadequate</td>
<td></td>
<td></td>
<td></td>
<td>Non-diagnostic Nondiagnostic or Unsatisfactory Nondiagnostic cystic lesion</td>
<td></td>
</tr>
<tr>
<td>Class 2 - Category 2 - Thy2 - II -</td>
<td></td>
<td></td>
<td></td>
<td>60% - 80%</td>
<td>0 - 3 %</td>
</tr>
<tr>
<td>Benign</td>
<td>Benign</td>
<td>Non-neoplastic</td>
<td>Benign</td>
<td>Thy2c -</td>
<td></td>
</tr>
<tr>
<td>Class 3 - Category 3 - Thy3a - III -</td>
<td></td>
<td></td>
<td></td>
<td>10% - 20%</td>
<td>5 - 15 %</td>
</tr>
</tbody>
</table>
Follicular lesion or suspicious for neoplasm - Neoplasm possible - Atypia or Follicular lesion of undetermined significance

Thy3f -

Neoplasm possible suggesting follicular neoplasm - Follicular neoplasm or suspicious for a follicular neoplasm

Class 4 - Thy4 - V - 2.5%- 10% 15 - 30 %

Class 5 - Category 4 - Thy5 - VI - 3.5%- 10% 97 - 100%

Suggested management for each category is referred to table 5.

Table 5

Suggested Action based on Cytologic diagnosis

AACE/AME/ETA 2010 (3) BTA2007(9)

Class 1 -
Repeated US-guided FNA biopsy, unless pure cyst.

Thy1 -
FNAC should be repeated. If cystic nodule has been aspirated to dryness with no residual mass, clinical/ultrasound follow-up alone may be sufficient.

Class 2 -
Clinical and US follow-up FNA biopsy repetition if nodule size increases or according to clinician's or cytopathologist's judgment.

Thy2 -
Two non-neoplastic results 3-6 months apart are generally advisable to exclude neoplasia. In high clinical risk group cases, the decision to proceed to lobectomy may be made even with a benign FNAC diagnosis.
Class 3 -
Surgery for most Frozen section usually not recommended. In some cases follow-up on the basis of a multidisciplinary team evaluation.

Thy3a -
These cases should be discussed in the MDT to decide on the appropriate course of action.

Thy3f -
Most of these patients should be treated by surgical removal of the lobe containing the nodule. Completion thyroidectomy may be necessary if the histology proves malignant.

Class 4 -
Surgery Frozen section recommended. Repeated FNA biopsy only if more material is needed.

Thy4 -
Surgical intervention is usually indicated for suspected cancer. Repeated FNA biopsy only if more material is needed.

Class 5 -
Surgery for differentiated carcinomas. Further diagnostic workup for anaplastic carcinomas, lymphomas, and metastatic lesions.

Thy5 -
The diagnosis should be discussed at the MDT meeting where further management should be agreed. Surgical intervention is indicated for DTC and MTC, depending on tumour size, clinical stage and other risk factors. Appropriate further investigation, radiotherapy and/or chemotherapy is indicated for anaplastic thyroid carcinoma, lymphoma or metastatic tumour.

TIPS

Evaluation of thyroid nodules has been successfully performed with comparable results between the two methods.

- In TIRADS:
  - category 4a: FNA could be avoided on account of the relative low risk of malignancy 3.3% (table 1).
  - This would reduce management cost.
  - 40.1% of the nodules aspirated in this study, were classified as 4a (with one suspicious feature).
• Malignancy is relatively higher in thyroid nodules with microcalcifications or microlobulated margins alone, than those nodules with two suspicious US features-solid and hypoechogenicity- combined.

• No US sign independently is fully predictive of a malignant lesion and coexistence of 2 or more suspicious US criteria greatly increases the risk of thyroid cancer\(^{(3)}\).

• Cancer risk is not lower in patients with small or impalpable nodules, ranges between 5.4% to 7.7% and appears similar for palpable lesions 5.0% to 6.5% \(^{(3)}\)\(^{(10)}\).

• Recognizing the suspicious features and performing Fine needle aspiration we believe is safer management for unexperienced radiologists.

• Recently published data regarding thyroid cancer detection for thyroid FNA, indicate a sensitivity for malignancy of between 65% and 98%, specificity of 76-100%, with a false negative rate of 0-5%, a false-positive rate of 0-5.7%, and an overall accuracy of 69-97%\(^{(5)}\).

Images for this section:
Fig. 1: Increased vascularity
Fig. 2: Microlobulations
Fig. 3: Taller than wider
Fig. 4: Hypoechoic & Irregular margins
**Fig. 5:** Solid with halo
Fig. 6: Calcification
Fig. 7: Cystic with solid component
Conclusion

• Junior radiologists in training are capable to categorize correctly thyroid nodules and performing FNA technique.

• Malignancy can be found even in non suspicious nodules.

• FNA remains the gold standard in evaluation of thyroid nodules.

• TIRADS could be a cost/effective method in the management of thyroid lesions.

Personal Information

V. Pavlidis

vpavlidis166@hotmail.com

References

3. Thyroid Nodule guidelines AACE/AME/ETA, Endocr Pract. 2010; vol 16 (Suppl 1).
4. Cooper et al. Revised American Thyroid Association Management Guidelines for Patients with Thyroid Nodules and Differentiated Thyroid Cancer. THYROID 2009: Volume 19, Number 11.
6. Theoharis et al. The Bethesda thyroid fine-needle aspiration classification system: Year 1 at an Academic institution. THYROID 2009: Vol 19, Number 11.


Abbreviations: