Assessment of the American College of Radiology Thyroid Imaging Reporting and Data System for Thyroid Nodule Malignancy Risk Stratification in a Pediatric Population

Jennifer E. Lim-Dunham¹, Iclal Erdem Toslak¹, Michael P. Reiter¹ and Brendan Martin²

Affiliations:
¹Department of Radiology, Loyola University Chicago Stritch School of Medicine, 2160 S First Ave, Maywood, IL 60153.
²Clinical Research Office, Loyola University Chicago Health Sciences Division, Loyola University Medical Center, Maywood, IL.

Citation:
Learning Objectives

By the end of this journal club, participants will be able to:

1. Understand how to use ACR TI-RADS
2. Identify high risk features of thyroid nodules
3. Discuss problems with using TI-RADS in pediatric populations
4. Understand accommodations for using TI-RADS in pediatric populations
Module Outline

I. Case
II. Background
III. Article Overview
IV. Clinical Questions
V. Key Points
Case – Presentation

A 15 yo female presents to her PCP with a lump in the left anterior part of her neck that she noticed approximately 6 weeks ago. It is non-tender, immobile, and moves up and down with swallowing. She denies hyper- and hypothyroid associated symptoms.

1. What is your differential diagnosis for a neck mass in a 15 yo F?
2. Possible next steps?

• Labs reveal normal thyroid function tests and negative thyroid autoantibodies.
• Ultrasound performed outside of UNC system reported 2.0 x 1.4 x 1.6 cm left thyroid nodule. ACR TI-RADS 3.
• Patient had a telemedicine visit with pediatric endocrinology who referred her to pediatric ENT. They ordered an FNA biopsy.
Case – Ultrasound
Case – Normal Anatomy Review

https://www.chop.edu/news/thyroid-cancer-happens
Case – Biopsy

A pathologist or cytotechnologist is preferably present for the biopsy to check for adequate sampling and diagnostic quality.
Case – Pathology Report

Final Diagnosis
A: Thyroid gland, left, fine needle aspiration
Benign (Bethesda Category II) (see comment)

Comment: The specimen contains benign-appearing follicular epithelium and colloid. These findings are consistent with a benign follicular nodule.

According to the Bethesda system for reporting thyroid cytopathology, the implied risk of malignancy for this diagnostic category is approximately 0-3%, and the recommended management is clinical follow up. The actual management may depend on other factors (e.g., clinical and sonographic findings).

- The Bethesda system for reporting thyroid cytopathology is a scoring system with 6 categories, each with an implied risk of malignancy and recommended management.
Case – Questions to Consider

• Why did this girl get a FNA biopsy? Was it appropriate?
• When do thyroid nodules warrant biopsy?
  • What characteristics of nodules are worrisome?
• Are thyroid biopsy guidelines different for pediatric patients?
• If the pathology report had come back with a higher suspicion for malignancy what are the next steps in management?
Module Outline

I. Case

II. Background

III. Article Overview

IV. Clinical Questions

V. Key Points
Background – ACR TI-RADS

• American College of Radiology Thyroid Imaging Reporting and Data System (ACR TI-RADS)
  • Standardized scoring system to determine need for FNA or ultrasound follow-up of suspicious thyroid nodules.
  • This was released in 2017. There are other TI-RADS systems originating from other countries or institutions.
  • This is the system you are most likely to encounter in practice now.

The following TI-RADS charts and examples are all available from the ACR:
https://www.acr.org/Clinical-Resources/Reporting-and-Data-Systems/TI-RADS
### ACR TI-RADS

**COMPOSITION**
- Cystic or almost completely cystic: 0 points
- Spongiform: 0 points
- Mixed cystic and solid: 1 point
- Solid or almost completely solid: 2 points

**ECHOGENICITY**
- Anechoic: 0 points
- Hyperechoic/isoechoic: 1 point
- Hypoechoic: 2 points
- Very hypoechoic: 3 points

**SHAPE**
- Wider-than-tall: 0 points
- Taller-than-wide: 3 points

**MARGIN**
- Smooth: 0 points
- Ill-defined: 0 points
- Lobulated or irregular: 2 points
- Extra-thyroidal extension: 3 points

**ECHOGENIC FOCI**
- None or large comet-tail artifacts: 0 points
- Microcalcifications: 1 point
- Peripheral (rim): 2 points
- Punctate echogetic foci: 3 points

---

Add Points From All Categories to Determine TI-RADS Level

<table>
<thead>
<tr>
<th>0 Points</th>
<th>2 Points</th>
<th>3 Points</th>
<th>4 to 6 Points</th>
<th>7 Points or More</th>
</tr>
</thead>
<tbody>
<tr>
<td>TR1</td>
<td>TR2</td>
<td>TR3</td>
<td>TR4</td>
<td>TR5</td>
</tr>
<tr>
<td>Benign</td>
<td>Not Suspicious</td>
<td>Moderately Suspicious</td>
<td>Highly Suspicious</td>
<td></td>
</tr>
<tr>
<td>No FNA</td>
<td>No FNA</td>
<td>FNA if ≥ 1.5 cm</td>
<td>FNA if ≥ 1 cm</td>
<td></td>
</tr>
</tbody>
</table>

**COMPOSITION**
- Spongiform: Composed predominantly (>50%) of small cystic spaces. Do not add further points for other categories.
- Mixed cystic and solid: Assign points for predominant solid component.
- Assign 2 points if composition cannot be determined because of calcification.

**ECHOGENICITY**
- Anechoic: Applies to cystic or almost completely cystic nodules.
- Hyperechoic/isoechoic/hypoechoic: Compared to adjacent parenchyma.
- Hypoechoic: More hypoechoic than strap muscles.
- Assign 1 point if echogenicity cannot be determined.

**SHAPE**
- Taller-than-wide: Should be assessed on a transverse image with measurements parallel to sound beam for height and perpendicular to sound beam for width.
- This can usually be assessed by visual inspection.

**MARGIN**
- Lobulated: Protrusions into adjacent tissue.
- Irregular, Jagged, spiculated, or sharp angles.
- Extra-thyroidal extension: obvious invasion = malignancy.
- Assign 0 points if margin cannot be determined.

**ECHOGENIC FOCI**
- Large comet-tail artifacts: V-shaped, >1 mm, in cystic components.
- Microcalcifications: Cause acoustic shadowing.
- Peripheral: Complete or incomplete along margin.
- Punctate echogetic foci: May have small comet-tail artifacts.

---

*Original text provided by JACR at: https://www.jacr.org/article/S1546-1440(17)30186-2/fulltext?_ga=2.188257452.525486094.1565030521-1858166925.1544129120

*Refer to discussion of papillary microcarcinomas for 5-0 mm TR5 nodules.
ACR TI-RADS™

**Composition**

- Cystic, almost completely cystic, or spongiform

**Echogenicity of Solid Components**

- Hyperechoic or Isoechoic (2 pt)
- Hypoechoic (3 pt)
- Very Hypoechoic (4 pt)

**Solid or almost completely solid**

- Hyperechoic or Isoechoic (3 pt)
- Hypoechoic (4 pt)
- Very Hypoechoic (5 pt)

**Other Features**

- Macroc alcifications: Add 1 pt
- Peripheral (rim) calcifications: Add 2 pt
- Punctate echogenic foci: Add 3 pt
- Lobulated or irregular margin: Add 2 pt
- Tailor-than-wide without extra-thyroidal extension: Add 3 pt
- Definite extra-thyroidal extension: Add 3 pt

**TI-RADS Level**

- 0 pt: TR1
  - No FNA or follow-up
- 2 pt: TR2
  - No FNA or follow-up
- 3 pt: TR3
  - FNA if ≥2.5 cm
  - Follow if ≥1.5 cm
  - No FNA or follow-up if <1.5 cm
- 4 – 6 pt: TR4
  - FNA if ≥1.5 cm
  - Follow if ≥1.0 cm
  - No FNA or follow-up if <1.0 cm
- >6 pt: TR5
  - FNA if ≥1.0 cm
  - Follow if ≥0.5 cm
  - No FNA or follow-up if <0.5 cm

---

1. Classify nodule as solid if composition cannot be determined
2. Classify nodule as isoechoic if echogenicity cannot be determined
3. Nodules with definite extra-thyroidal extension should be considered malignant until proven otherwise
Composition

Cystic or almost completely cystic (0 points)

Spongiform (0 points)

Mixed cystic and solid (1 point)

Solid or almost completely solid (2 points)
Echogenicity

Hyperechoic (1 point)
Isoechoic (1 point)
Anechoic (0 points)
Hypoechoic (2 points)
Very hypoechoic (3 points)
Shape, Margin, Echogenic Foci

- Taller-than-wide (3 points)
- Lobulated or irregular (2 points)
- Extra-thyroidal extension (3 points)
- Punctate echogenic foci (3 points)
- Peripheral (rim) calcifications (2 points)

(Not comprehensive – see ACR TI-RADS Atlas)
Module Outline

I. Case
II. Background
III. Article Overview
IV. Clinical Questions
V. Key Points
Purpose: To assess the diagnostic performance of the American College of Radiology (ACR) Thyroid Imaging Reporting and Data System (TI-RADS) for malignancy risk in pediatric thyroid nodules.


Study Type: Retrospective review of cases at Loyola University Medical Center 1996 – 2017.

Number of Cases: 74 tissue-proven thyroid nodules in 62 children (18 years and younger).

Data: Two pediatric radiologists individually scored and categorized all 74 ultrasound images.
Material and Method

- Images were produced using gray-scale sonography with color Doppler using a variety of ultrasound systems.

- Two pediatric radiologists blinded to tissue diagnosis assigned ACR TI-RADS categories to the 74 nodules.
  - The process was repeated >2 weeks later (to minimize recall bias).
  - During a third session the two radiologists worked together to reach consensus for nodules they had scored differently.

- Ultrasound-guided FNA biopsy was performed by one of two pediatric radiologists each with >10 years experience. Pathologists verified adequacy of samples.

- Categorization of malignant or benign was determined by surgical pathologic results for patients who underwent thyroidectomy and with cytopathologic results for those who did not.
Results

- Cohen's kappa coefficient (κ) is a statistic used to measure intra- and interobserver reliability for qualitative (categorical) items.
- Intraobserver agreement was “almost perfect” for all categories except echogenicity.
- Interobserver agreement was substantial for composition and shape, but only moderate for TI-RADS category. (46% of disagreements were between adjacent categories)
• Sensitivity (85%) and specificity (65%) were maximized with a cut point of TI-RADS category 5
• Positive predictive value: 47%
• Negative predictive value: 92%
• Category 5 nodules were 10.44 times more likely to be malignant ($p < 0.001$)
Discussion

• Authors conclude that TI-RADS is a helpful decision making tool in the management of pediatric thyroid nodules.

• Compared to other classification systems, ACR TI-RADS has increased accessibility, applicability, reputation, and acceptance in the United States.

• Anechoic vs. hypoechoic
  • This can be difficult to determine and can make a big impact on scoring.
  • There was one false negative in the study that was identified as anechoic and cystic, but was malignant—likely it was solid and hypoechoic.
Discussion

• Nodule size is not used in categorization, but does impact thresholds for biopsy and follow-up imaging recommendations.
  • In kids nodules size has less importance. **Suspicious nodules should be biopsied.**
  • Thyroid nodules are more likely to be malignant in children and warrant a more aggressive approach than in adults.

• There is a high rate of false positives and unnecessary FNA biopsy.
  • 35/38 nodules (92%) identified as categories 1-4 were benign and could have avoided FNA biopsy.
  • The risks associated with FNA biopsy are small. It seems appropriate to continue with a low threshold for FNA biopsy in pediatric patients.
Hold On!

- External Validity
  - Single academic institution.
  - Small sample size and even smaller number of malignant nodules \((n = 20)\).
  - Have used portions of the same data set for two previous studies.

- Retrospective
  - Use of different ultrasound vendors and variation in imaging quality.
  - They do not address the experience or consistency of those providing the pathology reports. What is their experience with cytology?
    - Use of a cut point on Bethesda class scale.

- Interobserver reliability
Module Outline

I. Case

II. Background

III. Article Overview

IV. Clinical Questions

V. Key Points
Clinical Questions

• At UNC how do we determine which thyroid nodules to biopsy in our pediatric population?
• The patient in our case saw her PCP, pediatric endocrinologist, and pediatric ENT. Who usually orders the FNA biopsy?
• Is the diagnostic algorithm in pediatric patients similar to adult patients?
Module Outline

I. Case
II. Background
III. Article Overview
IV. Clinical Questions
V. Key Points
Key Points

• ACR TI-RADS is an important thyroid nodule classification system to be familiar with.

• ACR TI-RADS was not designed specifically for the pediatric population.

• ACR TI-RADS useful for communication with its defined terminology and widely accepted system for classification, but in pediatric patients a suspicion of malignancy is enough to proceed with biopsy.

• Further study needs to be performed to assess the effectiveness of TI-RADS in appropriately classifying pediatric thyroid nodules.
References


