

# UPDATE IN SONOGRAPHIC CRITERIA FOR THE EVALUATION OF THYROID NODULES

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Metabolism and the American Board of Clinical Lipidology*

March 13, 2021



# DISCLOSURE

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- No conflicts of interests

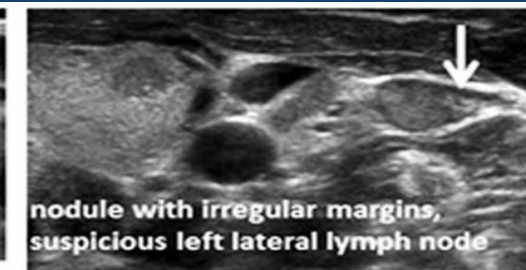
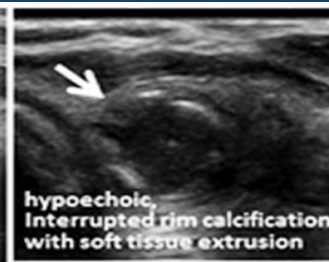
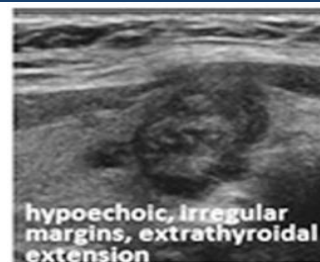
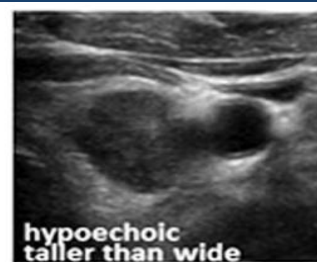
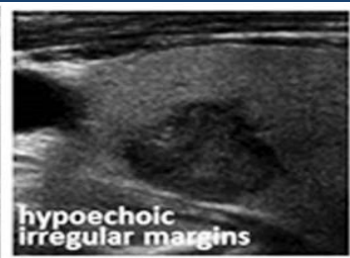


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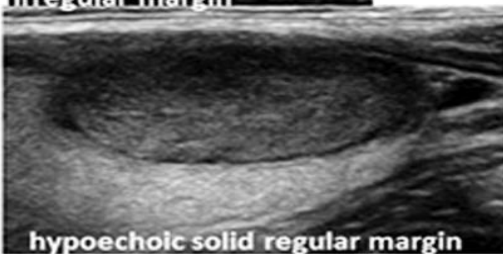
# LEARNING OBJECTIVES

- Ultrasound Risk Stratification Systems
  - American Thyroid Association (ATA)
  - American College Clinical Endocrinologists (AACE/ACE/AME)
  - American College Radiology (ACR-TIRADS)
- Does one size Fit all? Comparison
- New advances in Thyroid Ultrasound
  - Elastography
  - Artificial Intelligence
- What's new in the ATA 2021 guidelines “sneak peek”

High  
Suspicion  
>70-90%

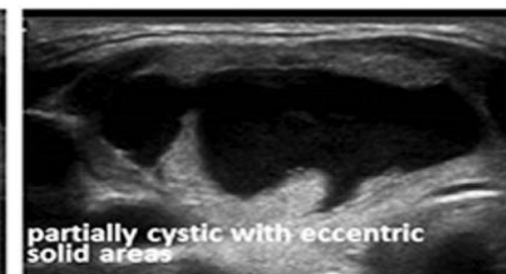
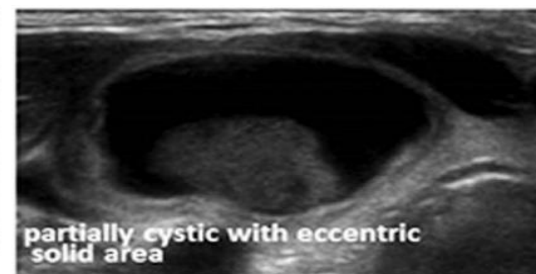
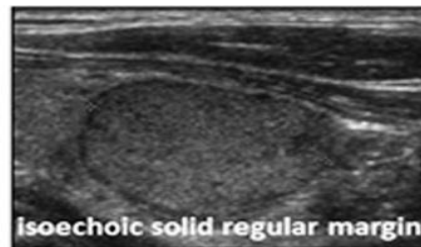


Intermediate  
Suspicion  
10-20%

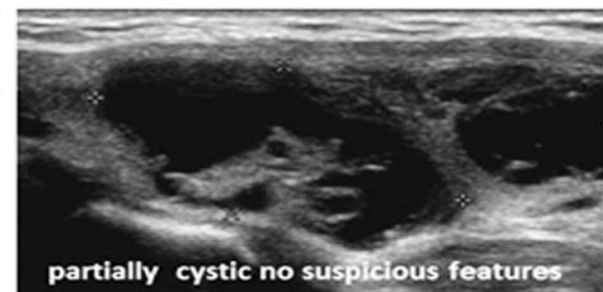
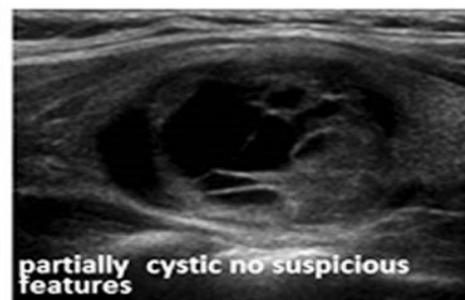


# PATTERN BASED

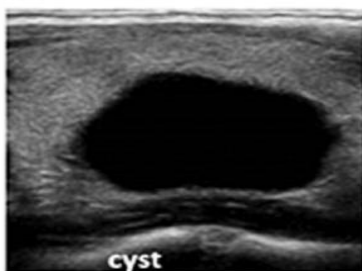
Low  
Suspicion  
5-10%



Very low  
Suspicion  
<3%



Benign  
<1%

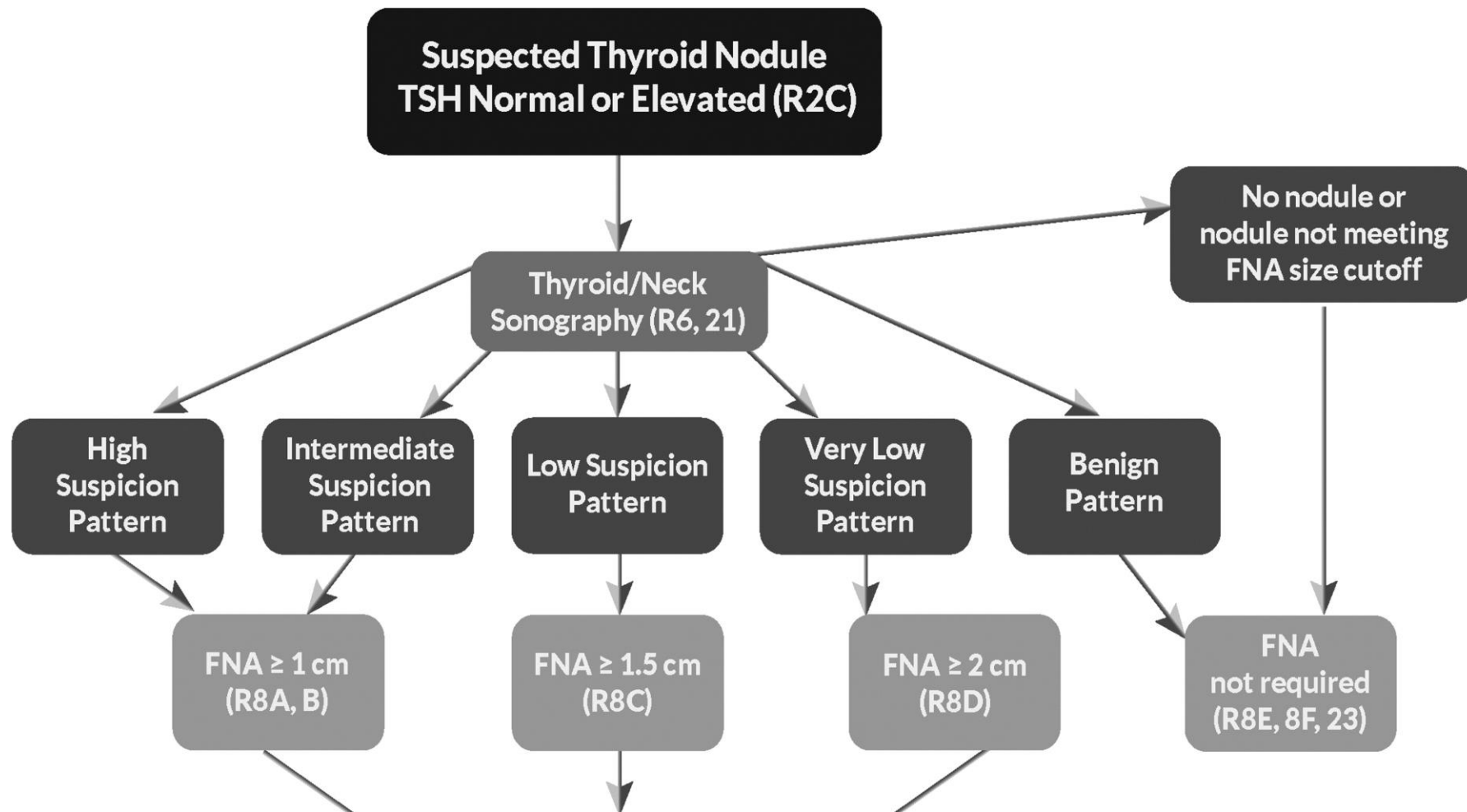


Risk of malignancy

# R8 US Pattern and suggested FNA cutoffs

Sonographic Pattern	Estimated malignancy risk	FNA size cutoff	Strength of rec	Quality of evidence
High suspicion	>70-90%	$\geq 1$ cm	Strong	Moderate
Intermediate suspicion	10-20%	$\geq 1$ cm	Strong	Low
Low suspicion	5-10%	$\geq 1.5$ cm	Weak	Low
Very low suspicion	< 3%	$\geq 2$ cm	Weak	Moderate
	<u>One option is surveillance</u>			
Benign	< 1%	No biopsy	Strong	Moderate
FNA is not recommended for nodules that do not meet the above criteria, including all nodules < 1 cm			Strong	Moderate

Haugen et al. Thyroid; January 2016

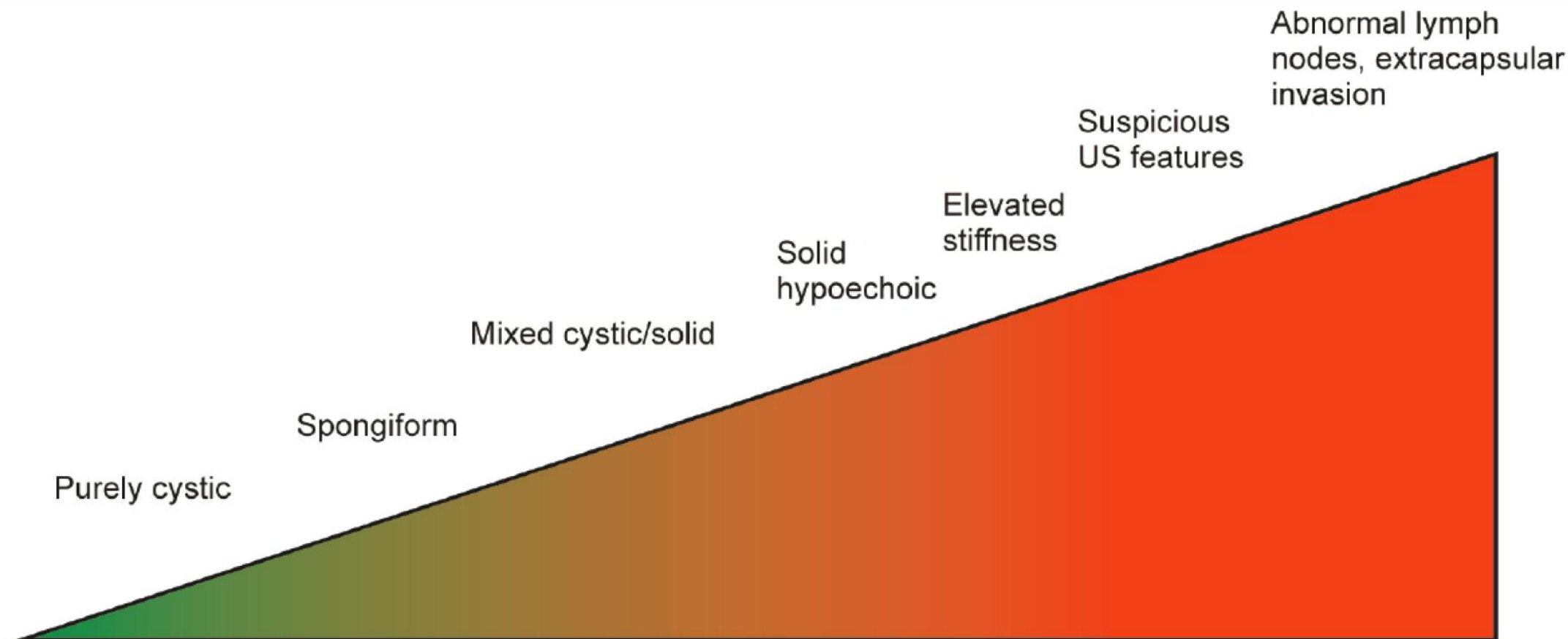




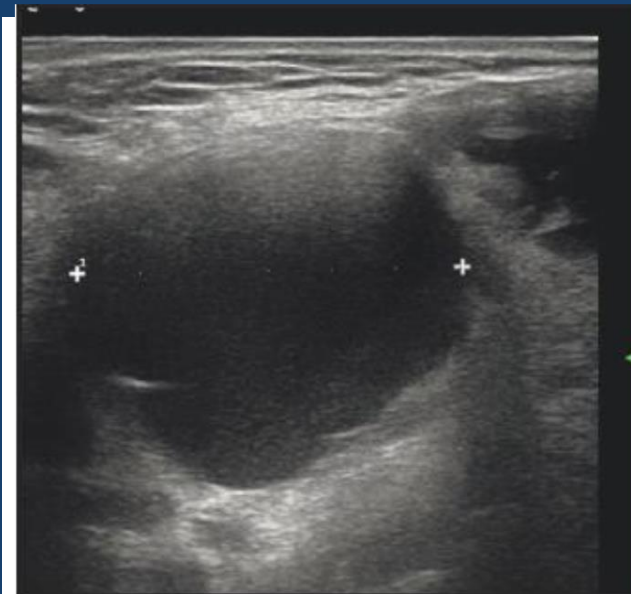
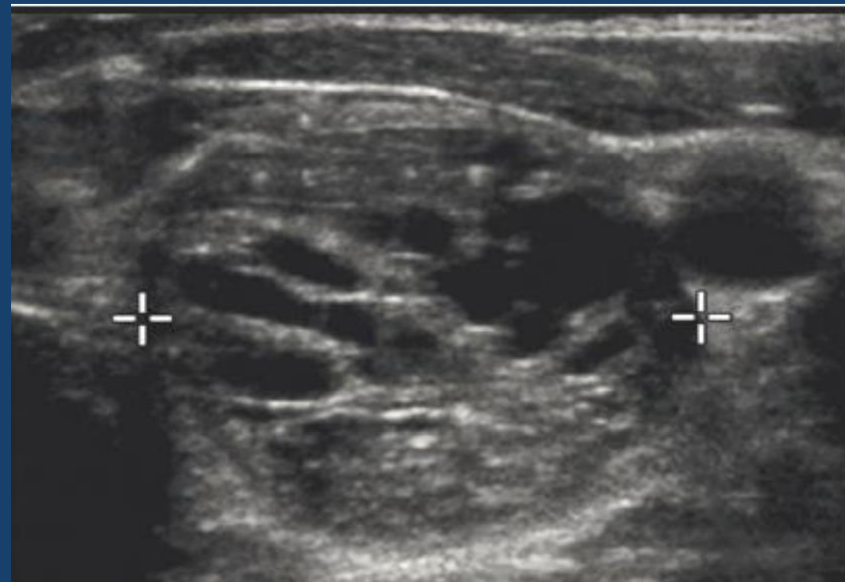
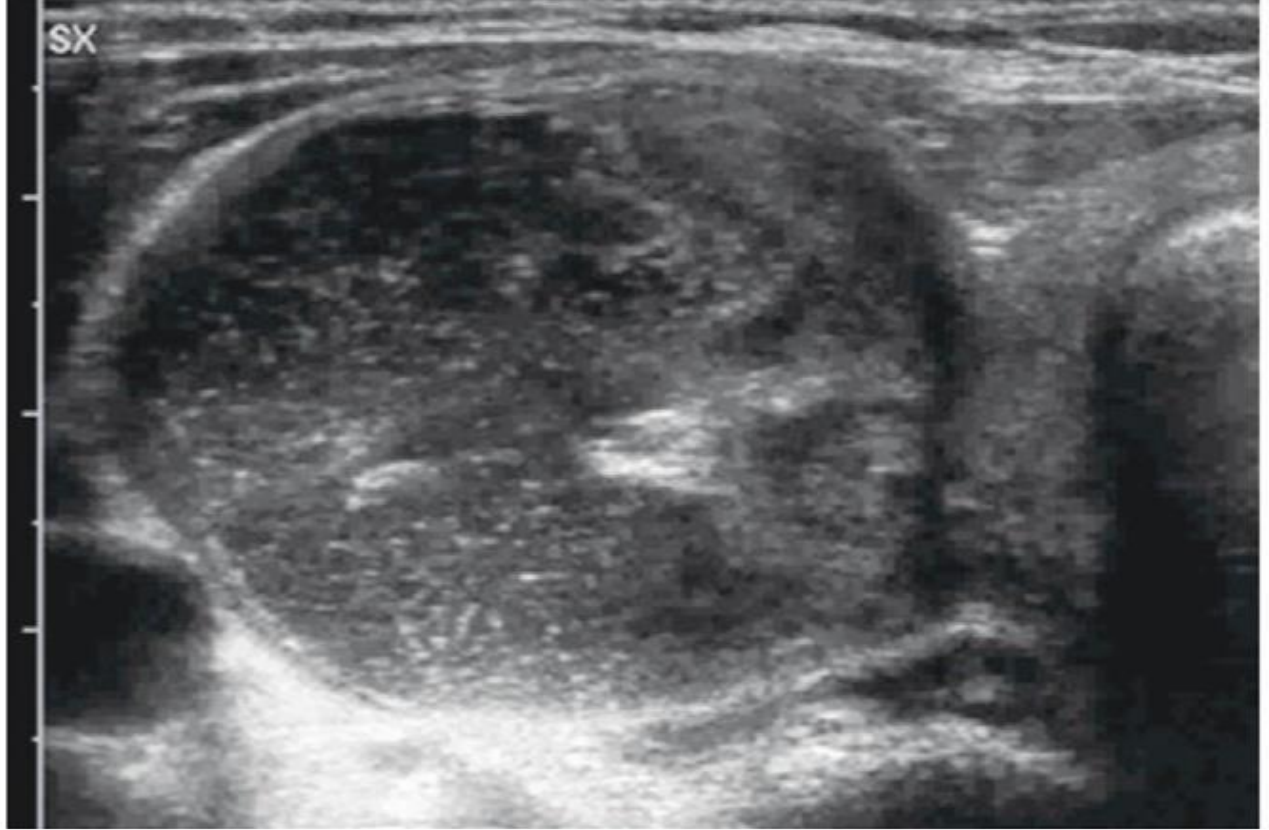


# AMERICAN COLLEGE CLINICAL ENDOCRINOLOGISTS 2016

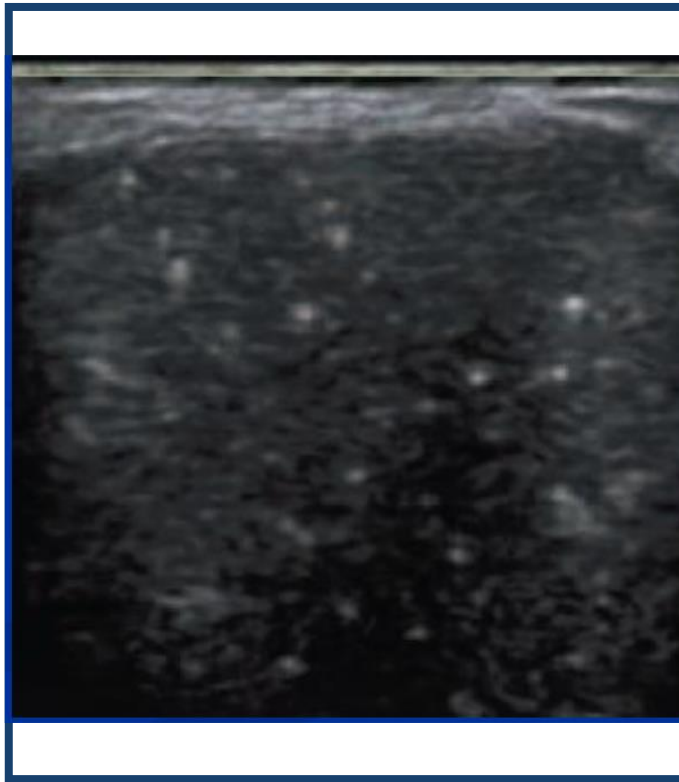
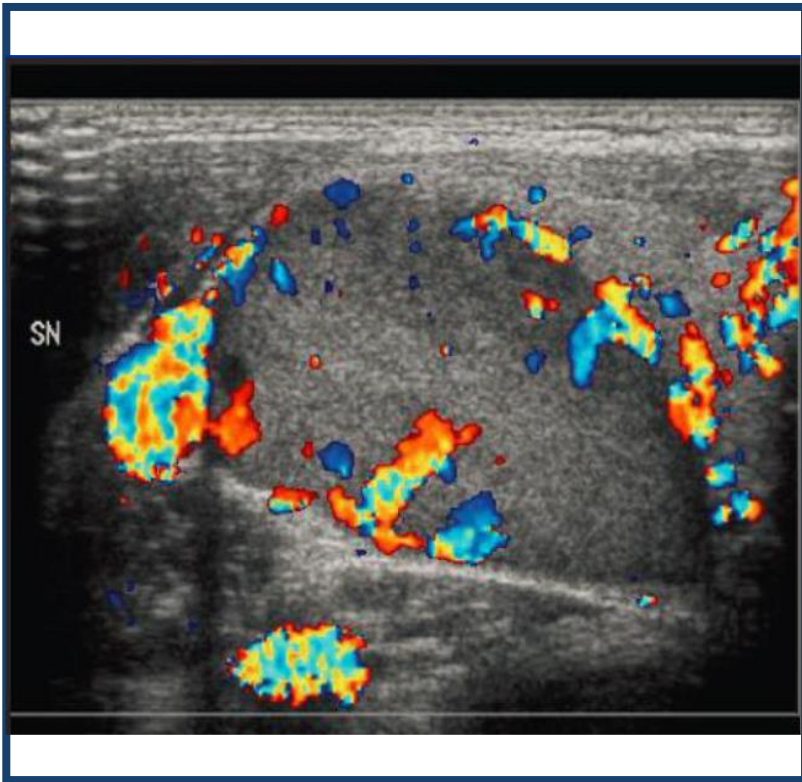
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LOW RISK: = 1 %

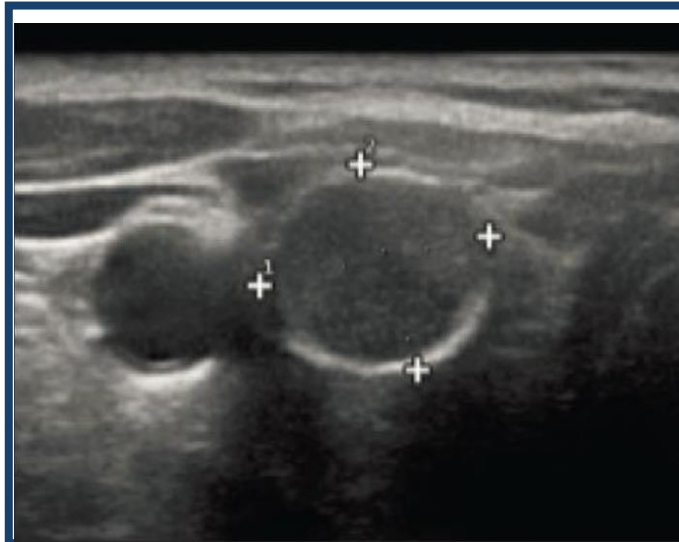






## INTERMEDIATE 5-15% ROM

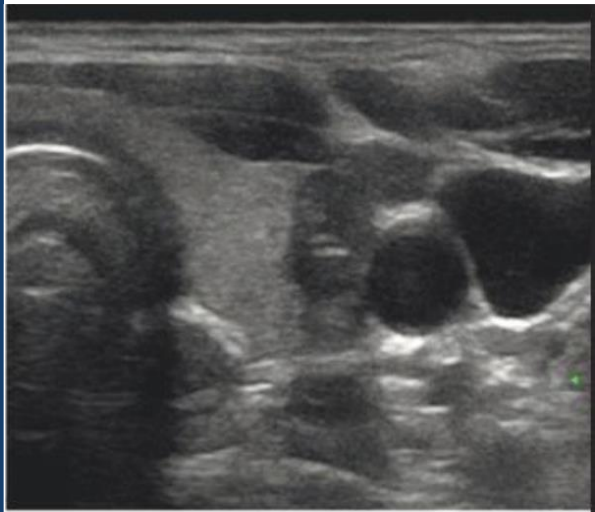
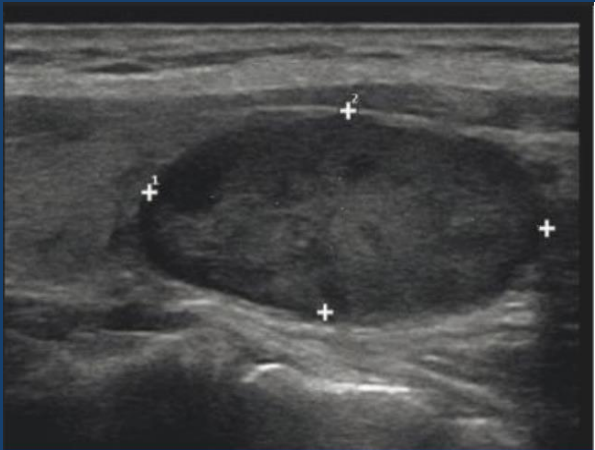
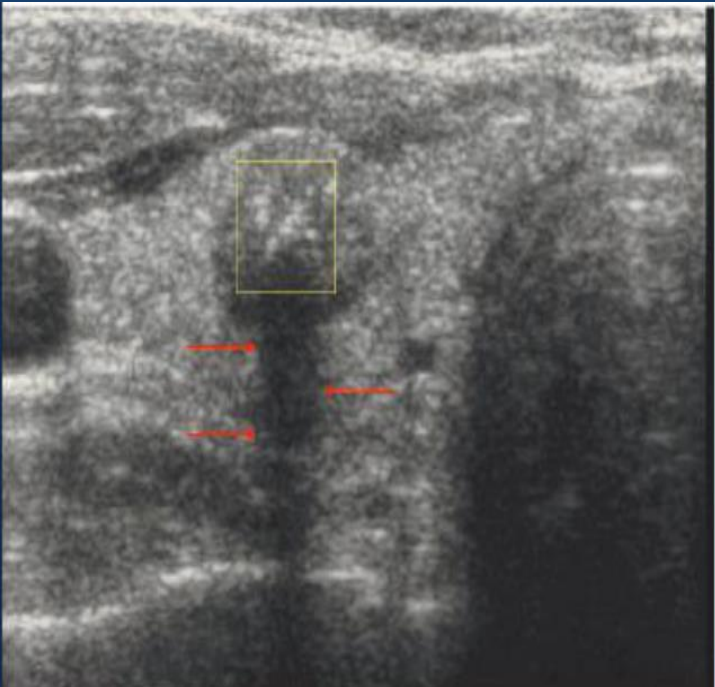
- Slightly hypoechoic or isoechoic nodules with ovoid-to-round shape and smooth or ill-defined margins
- Continuous rim calcifications, increased stiffness at elastography, or hyperechoic spots of uncertain significance may be present





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# HIGH RISK FOR MALIGNANCY: 50-90% ROM



US features indicative of a malignant nodule
Papillary carcinoma
Solid hypoechoic (relative to prethyroid muscles) nodule, which may contain hyperechoic foci without posterior shadowing (i.e., microcalcifications)
Solid hypoechoic nodule, with intranodular vascularity and absence of peripheral halo
“Taller-than-wide” nodule (AP>TR diameter when imaged in the transverse plane)
Hypoechoic nodule with spiculated or lobulated margin
Hypoechoic mass with a broken calcified rim and tissue extension beyond the calcified margin
Follicular neoplasm (either follicular adenoma or carcinoma)
Isoechoic or mildly hypoechoic homogeneous nodule with intranodular vascularization and well-defined halo



Sonographic Pattern	Estimated Malignancy Risk	Recommendation
High Risk US	50-90%	2
Intermediate Risk US	5-15%	2
Low Risk US	< 1%	2

As a general rule, which may be modified on the basis of the clinical setting and operator expertise, we recommend the following:

- In light of the low clinical risk, nodules <5 mm should be monitored, rather than biopsied, irrespective of their sonographic appearance.
- In nodules with a major diameter of 5 to 10 mm that are associated with suspicious US signs (high-US-risk thyroid lesions), consider either FNA sampling or watchful waiting on the basis of the clinical setting and patient preference. Specifically, FNA is recommended for the following nodules:
  - Subcapsular or paratracheal lesions
  - Suspicious lymph nodes or extrathyroid spread
  - Positive personal or family history of thyroid cancer
    - History of head and neck irradiation
    - Coexistent suspicious clinical findings (e.g., dysphonia)
- In nodules >10 mm that are associated with suspicious US signs (high US risk thyroid lesions), FNA is always recommended.



# AACE VS ATA

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AACE

- **Low risk**
  - Cysts (fluid component >80%)
  - Mostly cystic nodules with reverberating artifacts and no associated with suspicious US
  - Isoechoic spongiform nodules



ATA

- **Benign**
  - Purely cystic nodules
- **Very Low Suspicion**
  - Spongiform or partially cystic nodules without any of the US features
- **Low Suspicion**
  - Isoechoic or hyperechoic solid nodule, or partially cystic nodule with eccentric solid area





# AACE VS ATA

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AACE

- **Intermediate Risk**

- Slightly hypoechoic (vs. thyroid tissue) or isoechoic nodules, with ovoid-to-round shape, smooth or ill-defined margins
- May be present:
  - Intranodular vascularization
  - Elevated stiffness at elastography,
  - Macro or continuous rim calcifications
- Indeterminate hyperechoic spots



ATA

- **Indeterminate suspicion**

- Hypoechoic solid nodule with smooth margins without:
- Microcalcifications
- Extrathyroidal extension
- taller than wide shape



# AACE VS ATA

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AACE

- **High Risk**

- Nodules with at least 1 of the following features:
  - Marked hypoechogenicity
  - Spiculated or lobulated margins
  - Taller-than-wide shape
  - Extrathyroidal growth
  - Pathologic adenopathy
  - Expected risk of malignancy in accordance with the presence of 1 or more suspicious findings



ATA

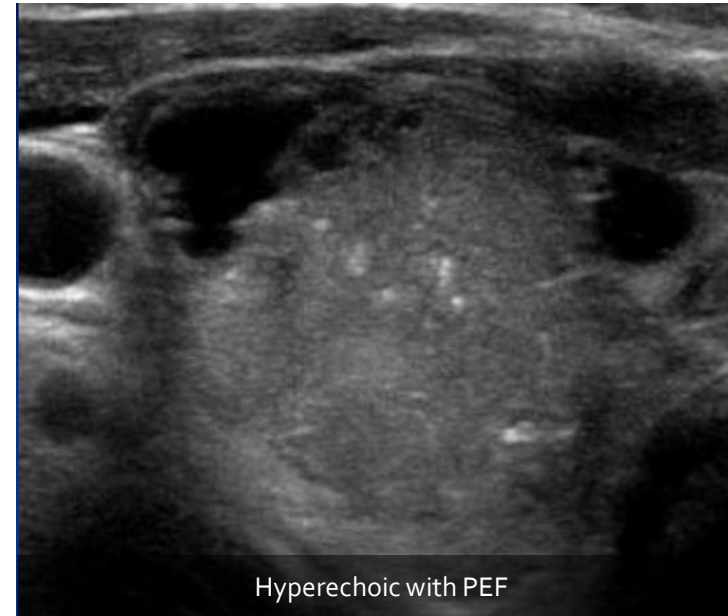
- **High Suspicion**

- Solid hypoechoic nodule or solid hypoechoic component of partially cystic nodule with 1 or more of the following features:
  - Irregular margins
  - Microcalcifications
  - Taller than wide shape
  - Rim calcifications with small extrusive soft tissue component
  - Evidence of extrathyroidal extension





Isoechoic with coarse calcifications



Hyperechoic with PEF

Sonographic pattern	US features	Estimated risk of malignancy, %	FNA size cutoff (largest dimension)
High suspicion	Solid hypoechoic nodule or solid hypoechoic component of a partially cystic nodule with one or more of the following features: irregular margins (infiltrative, microlobulated), microcalcifications, taller than wide shape, rim calcifications with small extrusive soft tissue component, evidence of ETE	>70–90 <sup>a</sup>	Recommend FNA at $\geq 1$ cm
Intermediate suspicion	Hypoechoic solid nodule with smooth margins without microcalcifications, ETE, or taller than wide shape	10–20	Recommend FNA at $\geq 1$ cm
Low suspicion	Isoechoic or hyperechoic solid nodule, or partially cystic nodule with eccentric solid areas, without microcalcification, irregular margin or ETE, or taller than wide shape	5–10	Recommend FNA at $\geq 1.5$ cm
Very low suspicion	Spongiform or partially cystic nodules without any of the sonographic features described in low, intermediate, or high suspicion patterns	<3	Consider FNA at $\geq 2$ cm observation without FNA is also a reasonable option
Benign	Purely cystic nodules (no solid component)	<1	No biopsy <sup>b</sup>

Adapted from Haugen et al., with permission from Mary Ann Liebert, Inc. [3].

FNA, fine needle aspiration; US, ultrasonography; ETE, extrathyroidal extension.

<sup>a</sup>The estimate is derived from high volume centers; the overall risk of malignancy may be lower given the interobserver variability in sonography. <sup>b</sup>Axial.

# ACR-TIRADS 2017

- Point Based System
  - Composition
  - Echogenicity
  - Shape
  - Margins
  - Echogenic Foci





**Figure 3:** Not specified pattern. US scan shows isoechoic nodule with irregular margins, microcalcifications (arrowheads), and taller-than-wide shape.

# Diagnostic Performance of TIRADS and 2014 ATA Guidelines

Parameter	TIRADS	2014 ATA Guidelines		P Value	
		All ATA Patterns	Not Specified Pattern	TIRADS vs All ATA Patterns	TIRADS vs Not Specified Pattern
Sensitivity (%)	97.4 (228/234) [95.4, 99.5]	95.3 (223/234) [92.6, 98.0]	91.0 (213/234) [87.4, 94.7]	.024	<.001
Specificity (%)	29.3 (310/1059) [26.5, 32.0]	37.4 (396/1059) [34.5, 40.3]	67.0 (705/1059) [64.1, 69.8]	<.001	<.001
PPV (%)	23.3 (228/977) [20.7, 26.0]	25.2 (223/886) [22.3, 28.0]	37.8 (213/563) [33.8, 41.8]	<.001	<.001
NPV (%)	98.1 (310/316) [96.6, 99.6]	97.3 (396/407) [95.7, 98.9]	97.1 (709/730) [95.9, 98.3]	.157	.150
Accuracy (%)	41.6 (538/1293) [38.9, 44.3]	47.9 (619/1293) [45.2, 50.6]	71.3 (922/1293) [68.8, 73.8]	<.001	<.001

Note.—Numbers in parentheses are raw data. Numbers in brackets are 95% confidence intervals. NPV = negative predictive value.

Scoring System and Category	Characteristics	Benign (n = 1059)	Malignant (n = 234)	Malignancy Risk (%)	Malignancy Rate (%) <sup>†</sup>	P Value
<b>TIRADS</b>						<.001
3	No suspicious US features	310 (29.3)	6 (2.6)	1.7	1.9 (0.8)	
4a	One suspicious US feature	391 (36.9)	17 (7.3)	3.3	4.2 (1.0)	
4b	Two suspicious US features	223 (21.1)	33 (14.1)	9.2	12.9 (2.2)	
4c	Three or four suspicious US features	131 (12.4)	130 (55.5)	44.4–72.4	49.8 (3.2)	
5	Five suspicious US features	4 (0.3)	48 (20.5)	87.5	92.3 (3.7)	
<b>ATA guidelines</b>						<.001
Very low suspicion	Spongiform or partially cystic nodule without any suspicious US features	396 (37.4)	11 (4.7)	<3	2.7 (0.8)	
Low suspicion	Iso- or hyperechoic solid nodule or partially cystic nodule without microcalcifications, irregular margin or extrathyroidal extension, and taller-than-wide shape	313 (29.6)	10 (4.3)	5–10	3.1 (1.1)	
Intermediate suspicion	Hypoechoic solid nodule with smooth regular margin	194 (18.3)	39 (16.7)	10–20	16.7 (2.5)	
High suspicion	Solid hypoechoic or partially cystic hypoechoic nodule with irregular margins, microcalcifications, taller-than-wide shape, disrupted rim calcification with hypoechoic soft tissue extension, and extrathyroidal extension	120 (11.3)	166 (70.9)	>70–90	58.0 (3.0)	
Not specified	Solid isoechoic or partially cystic isoechoic nodule with irregular margins, microcalcifications, and taller-than-wide shape	36 (3.4)	8 (3.4)	Not mentioned	18.2 (5.8)	

Note.—Suspicious US features are solidity, hypoechogenicity or marked hypoechogenicity, microlobulated to irregular margin, microcalcifications or mixed calcifications, and nonparallel shape.

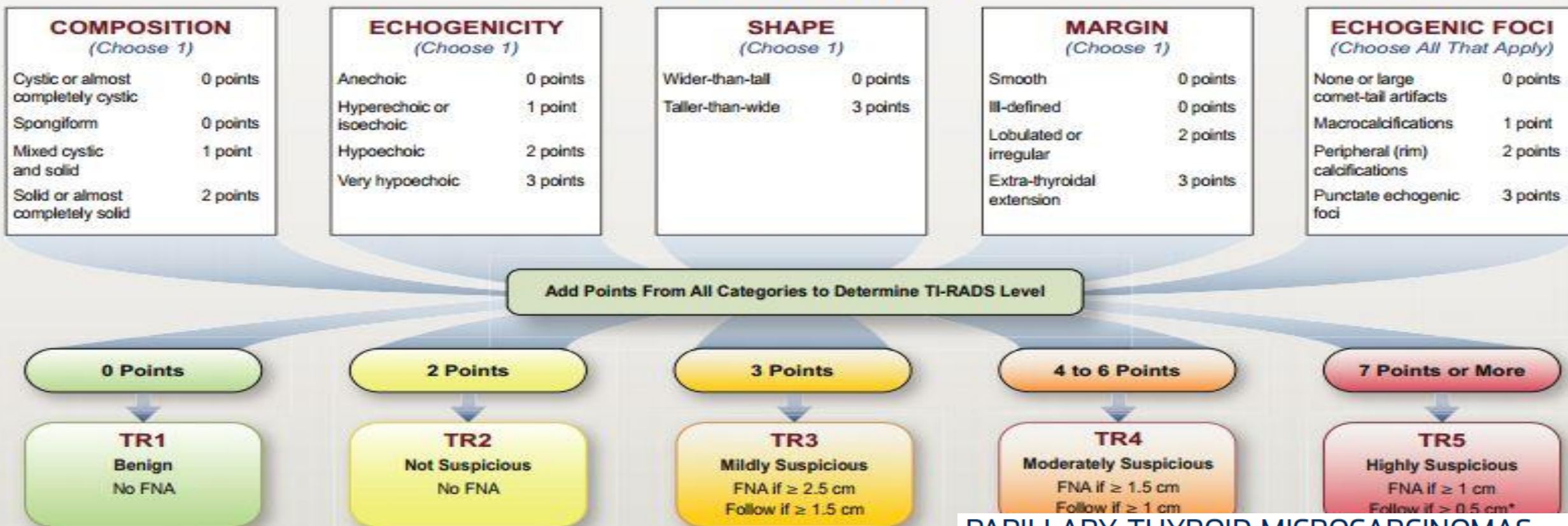
\* Data are numbers of patients, with percentages in parentheses.

<sup>†</sup> Numbers in parentheses are standard errors.

## Malignancy Risk Stratification of Thyroid Nodules: Comparison between the Thyroid Imaging Reporting and Data System and the 2014 American Thyroid Association Management Guidelines<sup>1</sup>



# ACR TI-RADS



## PAPILLARY THYROID MICROCARCINOMAS

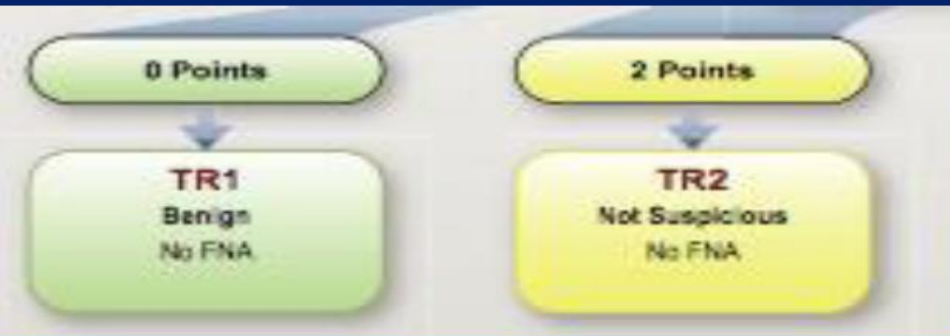
The ACR TI-RADS is concordant with other guidelines in recommending against routine biopsy of nodules smaller than 1 cm, even if they are highly suspicious. However, because some thyroid specialists advocate active surveillance, ablation, or lobectomy for papillary microcarcinomas, biopsy of 5- to 9-mm TR5 nodules may be appropriate under certain circumstances [24,55-57]. The

COMPOSITION	ECHOGENICITY	SHAPE
<p><b>Spongiform:</b> Composed predominantly (&gt;50%) of small cystic spaces. Do not add further points for other categories.</p> <p><b>Mixed cystic and solid:</b> Assign points for predominant solid component.</p> <p>Assign 2 points if composition cannot be determined because of calcification.</p>	<p><b>Anechoic:</b> Applies to cystic or almost completely cystic nodules.</p> <p><b>Hyperechoic/isoechoic/hypoechoic:</b> Compared to adjacent parenchyma.</p> <p><b>Very hypoechoic:</b> More hypoechoic than strap muscles.</p> <p>Assign 1 point if echogenicity cannot be determined.</p>	<p><b>Taller-than-wide:</b> Should be assessed on a transverse image with measurements parallel to sound beam for height and perpendicular to sound beam for width.</p> <p>This can usually be assessed by visual inspection.</p>

\*Refer to discussion of papillary microcarcinomas for 5-9 mm TR5 nodules.



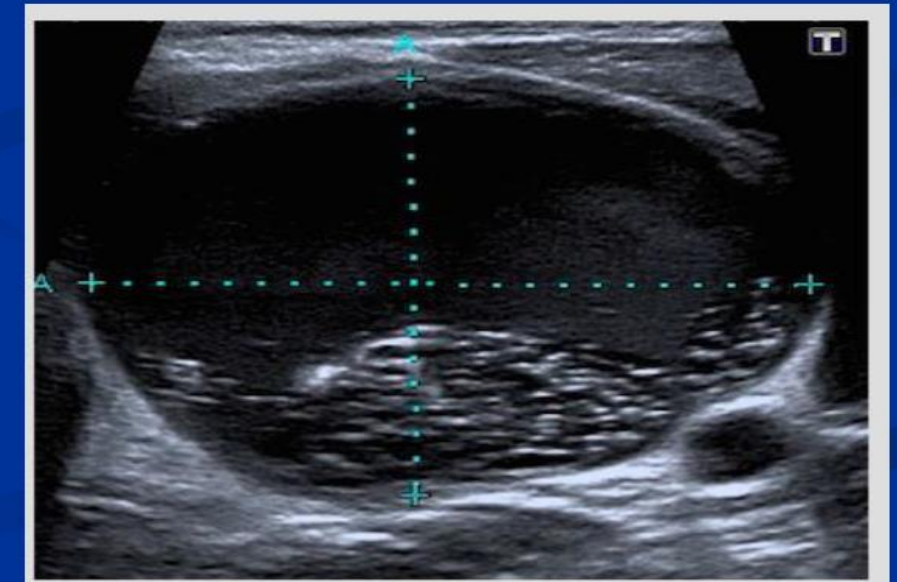
# Cystic or almost completely cystic almost universally benign



Spongiform composition – 0 points  
Colloid cyst

Mixed Cystic-Solid -- 2 points  
(w/ no suspicious features)

**No FNA**



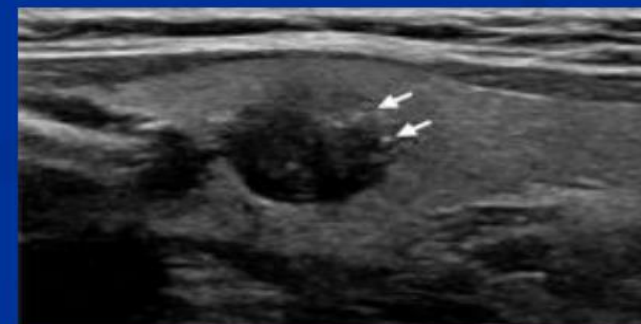
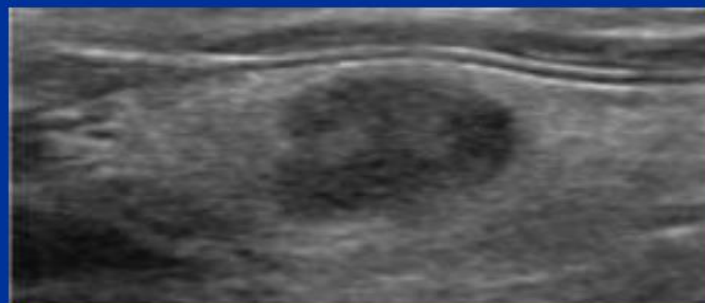
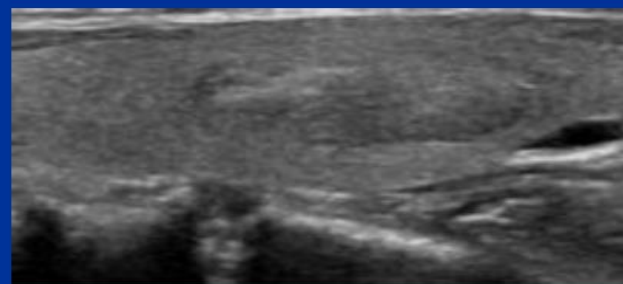
Russ G. *Ultrasonography* 2016; 35: 25-38  
Moon WJ *Radiology* 2008; 247: 762-770  
Lee et al. *Thyroid* 2009; 19(4): 341-346

# ACR TI-RADS System FNA

## Indications TIRADS 3-5



**Consider FNA**



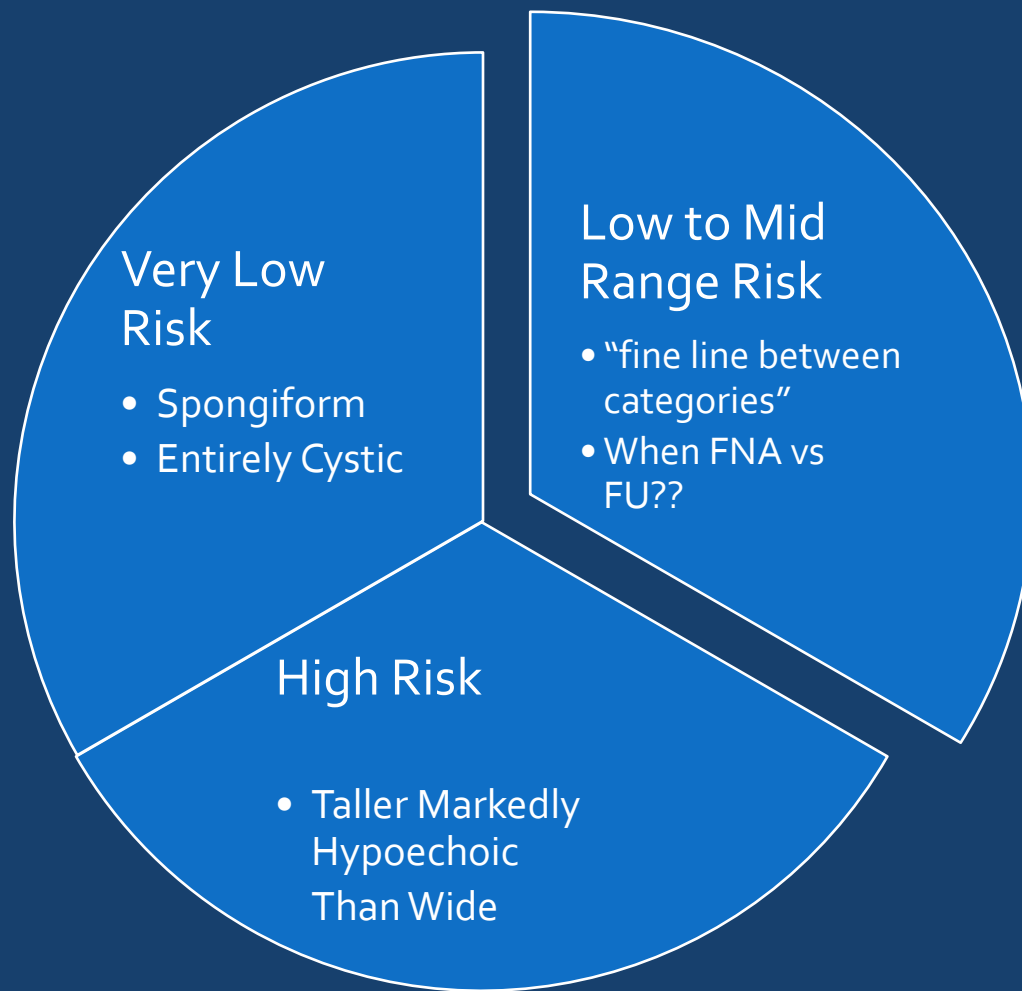






# RISK STRATIFICATION

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# Performance of Five Ultrasound Risk Stratification Systems in Selecting Thyroid Nodules for FNA

Marco Castellana,<sup>1</sup> Carlo Castellana,<sup>2</sup> Giorgio Treglia,<sup>3,4</sup> Francesco Giorgino,<sup>3,5</sup> Luca Giovannella,<sup>3,5</sup> Gilles Russ,<sup>6,7</sup> and Pierpaolo Trimboli<sup>3,8</sup>

Table 4. Head-to-head comparison of DOR of ultrasound risk stratification systems for selecting thyroid nodules for FNA

US RSS A	US RSS B	Number of nodules (number of studies)	DOR of US RSS A	DOR of US RSS B	RDOR	P
ACR TI-RADS	ATA	8491 (6)	5.6 (3.4-9.2)	3.3 (1.3-8.5)	1.8 (1.3-2.3)	0.002

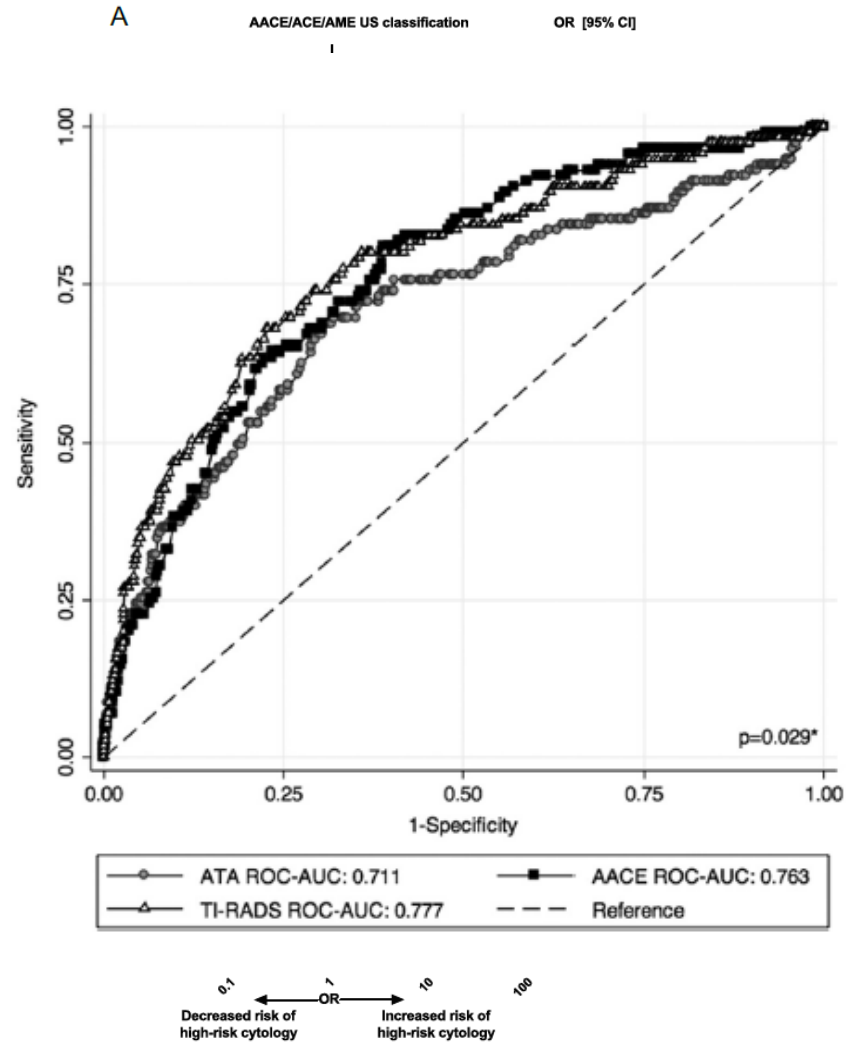
Table 5. Head-to-head comparison of LR+ of ultrasound risk stratification systems for selecting thyroid nodules for FNA

US RSS A	US RSS B	Number of nodules (number of studies)	LR+ of US RSS A	LR+ of US RSS B	RLR+	P
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Table 6. Head-to-head comparison of LR- of ultrasound risk stratification systems for selecting thyroid nodules for FNA

US RSS A	US RSS B	Number of nodules (number of studies)	LR- of US RSS A	LR- of US RSS B	RLR-	P
ACR TI-RADS	ATA	8491 (6)	0.4 (0.3-0.5)	0.4 (0.2-0.8)	0.8 (0.6-1.2)	0.338
ATA	K-TIRADS	6692 (4)	0.5 (0.2-0.9)	0.5 (0.2-0.9)	1.2 (1.0-1.4)	0.114
ACR-TIRADS	K-TIRADS	9291 (5)	0.4 (0.3-0.7)	0.4 (0.2-0.9)	0.9 (0.6-1.4)	0.673

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## Differences between ATA, AACE/ACE/AME and ACR TI-RADS ultrasound classifications performance in identifying cytological high-risk thyroid nodules

A Lauria Pantano<sup>1,\*</sup>, E Maddaloni<sup>1,\*</sup>, S I Briganti<sup>1</sup>, G Beretta Anguissola<sup>1</sup>, E Perrella<sup>2</sup>, C Taffon<sup>2</sup>, A Palermo<sup>1</sup>, P Pozzilli<sup>1</sup>, S Manfrini<sup>1</sup> and A Crescenzi<sup>2</sup>



- Sosa et al. in a retrospective studies of nodules >5mm that underwent surgery were evaluated.
- The ATA and TI-RADS classification systems appear to have similar diagnostic value for predicting thyroid cancer.
- In a Sub-analysis of TR<sub>3</sub> and TR<sub>4</sub> nodules
  - 10% of malignancies were missed in the TR<sub>3</sub> classification.
  - 38% of malignancies were missed in the TR<sub>4</sub> classification

Table 5 Comparison of the Diagnostic Performance of ATA and ACR TI-RADS Classification		
	ATA classification	ACR TI-RADS classification
Sensitivity, (95% CI)	77.3 (68.5-86.0)	78.4 (69.8-87.0)
Specificity, (95% CI)	76.6 (71.2-82.0)	73.2 (67.5-78.9)
Positive predictive value, (95% CI)	55.3 (46.5-64.1)	52.3 (43.7-60.8)
Negative predictive value, (95% CI)	90.0 (85.8-94.8)	90.1 (85.8-94.3)
AUC (P = .18)	0.77	0.76
Kappa statistics (95% CI)	0.93 (88.8-97.0)	

Abbreviations: ACR TI-RADS = American College of Radiology Thyroid Imaging Reporting and Data System; ATA = American Thyroid Association; AUC = area under the curve; CI = confidence interval.

ATA and ACR TI-RADS:

- ATA Benign/very low/low suspicion are negative.
- ATA intermediate/high are positive.
- ACR TI-RADS 1/2/3 are negative.
- ACR TI-RADS 4/5 are positive.

Table 6 Malignancy Rate Within Each ATA and ACR TI-RADS		
ACR TI-RADS classification	Total nodules	Malignant nodules (%)
5	32	29 (90.6)
4	100	40 (40)
3	159	16 (10.1)
2	26	3(11.5)
1	6	0 (0.0)
<b>ATA classification</b>		
High	52	44 (84.6)
Intermediate	71	24 (33.8)
Low	179	19 (10.6)
Very low	16	1 (6.3)
Benign	5	0 (0.0)

Abbreviations: ACR TI-RADS = American College of Radiology Thyroid Imaging Reporting and Data System; ATA = American Thyroid Association.



# Comparison of different systems of ultrasound (US) risk stratification for malignancy in elderly patients with thyroid nodules. Real world experience

**Table 2** Comparison of malignant cytology within the categories of each US classification

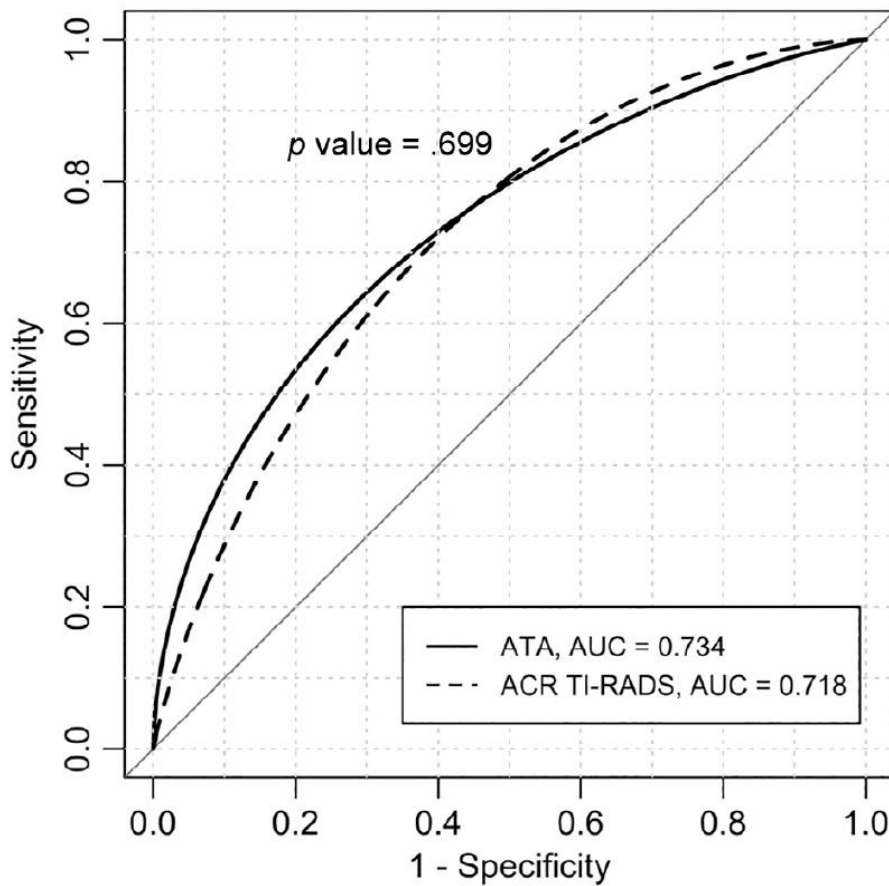
	<i>n</i> (%)	Malignant cytology <i>n</i> (%)	<i>p</i> for trend
ACR TI-RADS ( <i>n</i> = 1587)			
TR 1	39 (2.4%)	–	0.028
TR 2	105 (6.6%)	2 (1.9%)	
TR 3	422 (26.6%)	8 (1.9%)	
TR 4	730 (46.0%)	23 (3.1%)	
TR 5	291 (18.3%)	17 (5.8%)	
ATA ( <i>n</i> = 1285)			
Benign	13 (1.0%)	–	<0.001
Very low suspicion	20 (1.6%)	1 (5%)	
Low suspicion	716 (55.7%)	9 (1.3%)	
Intermediate suspicion	281 (21.9%)	9 (3.2%)	
High suspicion	255 (19.8%)	17 (6.7%)	
AACE/ACE/AME ( <i>n</i> = 1495)			
Class 1	31 (2.1%)	2 (6.5%)	<0.001
Class 2	725 (48.5%)	11 (1.5%)	
Class 3	739 (49.4%)	35 (4.7%)	

**Table 3** Paired-comparison of ROC curves

(AUC)	Z value	<i>p</i> value
Unclassifiable malignant nodules categorized in the lowest risk category (1234, <i>M</i> = 50)		
ATA (0.49) vs. ACR TI-RADS (0.62)	2.65	0.008
ATA vs. AACE/ACE/AME (0.59)	2.28	0.022
AACE/ACE/AME vs. ACR TI-RADS	−0.58	0.56
Excluding all unclassifiable nodules ( <i>n</i> = 1218, <i>M</i> = 34)		
ATA (0.68) vs. ACR TI-RADS (0.61)	−2.56	0.01
ATA vs. AACE/ACE/AME (0.59)	−2.88	<0.001
AACE/ACE/AME vs. ACR TI-RADS	−0.73	0.46

*AUC* area under the curve





**Figure 1.** Receiver operating characteristic curves of ATA and ACR TI-RADS risk stratification systems.  
Abbreviations: ACR TI-RADS, American College of Radiology Thyroid Imaging and Reporting Data System; ATA, 2015 American Thyroid Association Guidelines; AUC, area under the curve.

## Endocrinology

biopsy criteria

Sensitivity	Specificity	NPV	PPV
92%	10%	79%	27%
74%	47%	84%	33%

thyroid Imaging and Reporting Data System; ATA, 2015 American Thyroid Association predictive value.

R,<sup>c</sup> STUART BENTLEY-HIBBERT,<sup>c</sup> ROBERT J. McCONNELL,<sup>b,d</sup> JAMES A. LEE,<sup>d,e</sup>

# Inter- and Intra-Observer Agreement in the Assessment of Thyroid Nodule Ultrasound Features and Classification systems: A Blinded Multicenter Study

## Inter-observer agreement

US System Classification	Cohen's K
AACE/ACE/AME	0.44
ATA	0.34
TI-RADS	0.42

## Intra-observer agreement

US System Classification	Cohen's K
AACE/ACE/AME	0.54
ATA	0.38
TI-RADS	0.49

# US FEATURES

## Inter-observer agreement

US features	Cohen's K
Composition	0.53
Echogenicity	0.47
Margins	0.33
Intranodular Vascularity	0.46
Microcalcifications	0.47
Macrocalcifications	0.38
Egg Shell calcifications	0.65
Comet Tail artifact	0.11
Taller than Wide	0.47

## Intra-observer agreement

US features	Cohen's K
Composition	0.58
Echogenicity	0.60
Margins	0.39
Intranodular Vascularity	0.62
Microcalcifications	0.55
Macrocalcifications	0.54
Egg Shell calcifications	0.96
Comet Tail artifact	0.47
Taller than Wide	0.35

**Table 3. Inter-observer agreement for the  
and single-center studies**

Value of Kappa	Level of Agreement	% of Data that are Reliable
0–.20	None	0–4%
.21–.39	Minimal	4–15%
.40–.59	Weak	15–35%
.60–.79	Moderate	35–63%
.80–.90	Strong	64–81%
Above .90	Almost Perfect	82–100%

Multi-center			Single-center			
US Classification System	Present study		Persichetti (2018)	Grani (2018)	Hoang (2018)	Pang (2019)
AACE/ACE/AME	0.44		0.82	0.73	-	-
ATA	0.34		0.76	0.75	-	0.51
EU-Tirads	0.39		-	0.68	-	-
ACR	0.42		-	0.61	0.51	-

Inter-observer agreement is expressed with Cohen's K



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# GUIDELINE APPROACHES

- Qualitative/Pattern approach versus Point System approach
  - ATA (KRADS, AACE, EMA, French TIRADS): uses description and patterns to determine level of suspicion
  - ACR-TIRADS uses points: allows for all nodules to be assigned a risk category and for future point adjustments
  - Both ATA and ACR TI-RADS use a 5 tier system.
- Patient population:
  - ACR-TIRADS is applicable to low risk adults with “incidental nodules”
    - Not applicable to patients with genetic risk
  - ATA applies to all patients.



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# WHAT IS THE FUTURE OF FNA GUIDELINES?

- The American College of Radiology is monitoring the performance of ACR-RI-RADS in both academic and private practice
- American Thyroid Association Nodule Task Force is updating the 2015 ATA guidelines
- International Group composed of representatives from AACE/AME, ACR, ATA, ETA and KTHRS leader discussion harmonization into a single universal guideline. (International Thyroid Nodule Ultrasound Working Group)



# ADVANCES



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# ELASTOGRAPHY

- Promising new technology to distinguish benign thyroid nodules from thyroid cancer through tissue stiffness measurement.
- Tissue inflammation and neoplastic processes can change tissue composition and stiffness.
- This technique investigates differences in the mechanical properties of structures by applying an external force and monitoring the deformation response
- Low relative displacement is linked to decreased elasticity and a higher probability of malignancy.



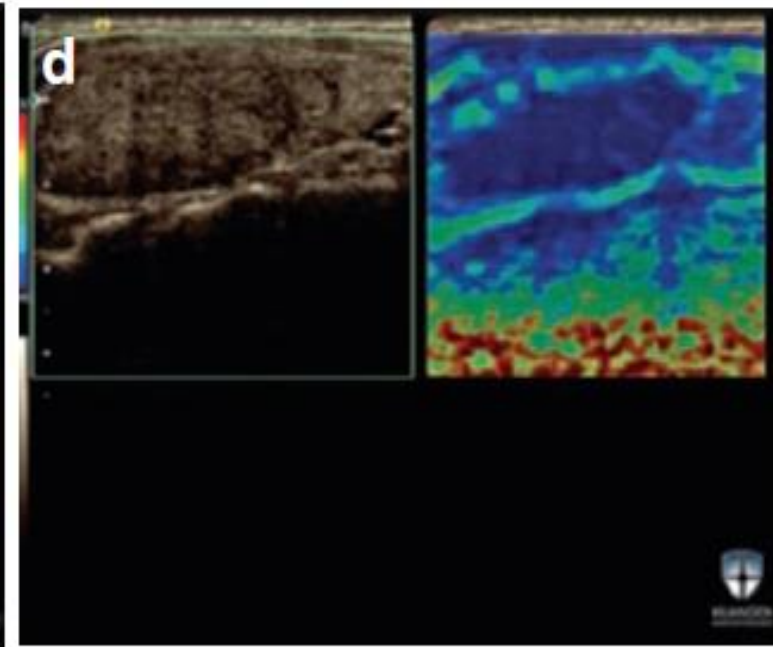
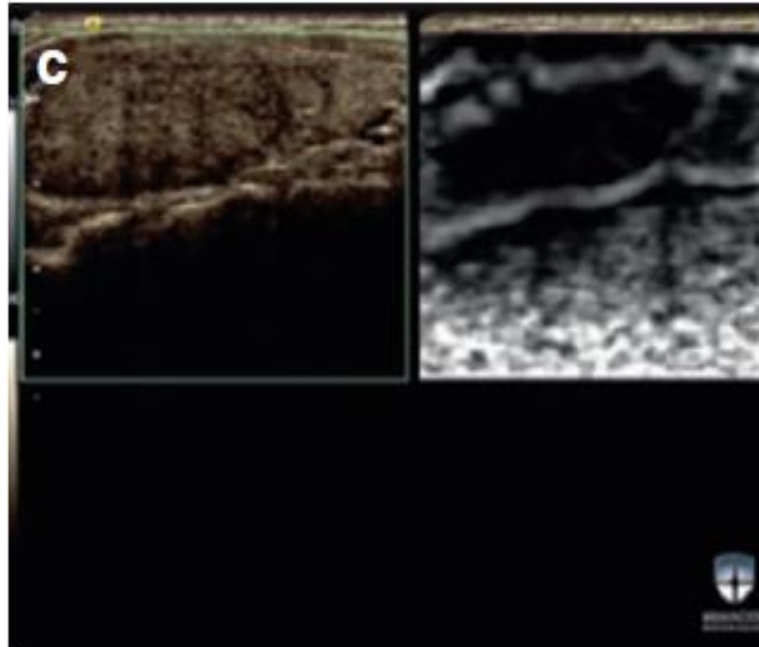
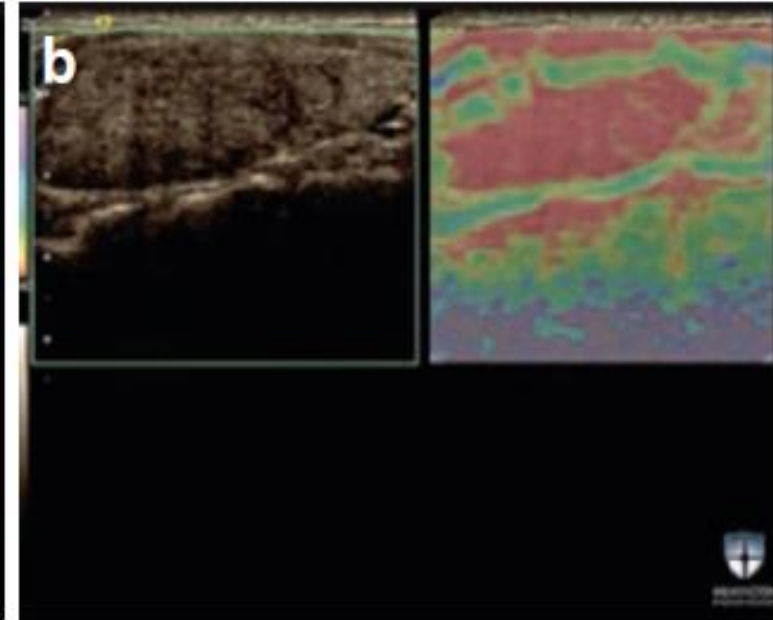
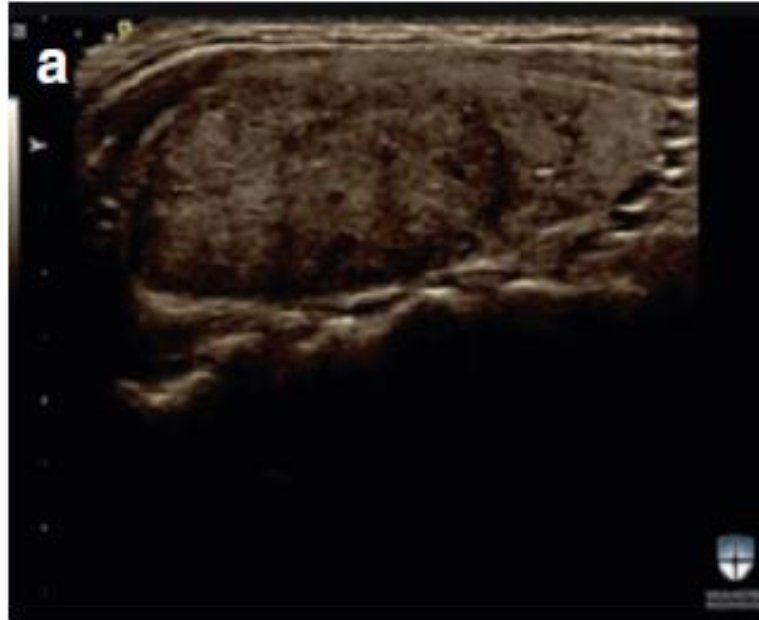
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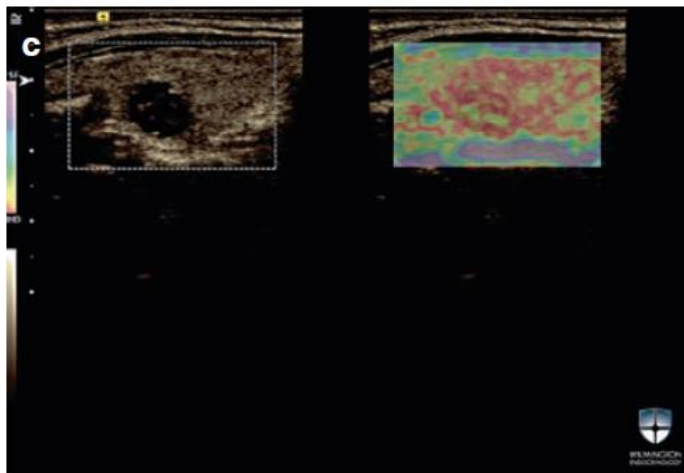
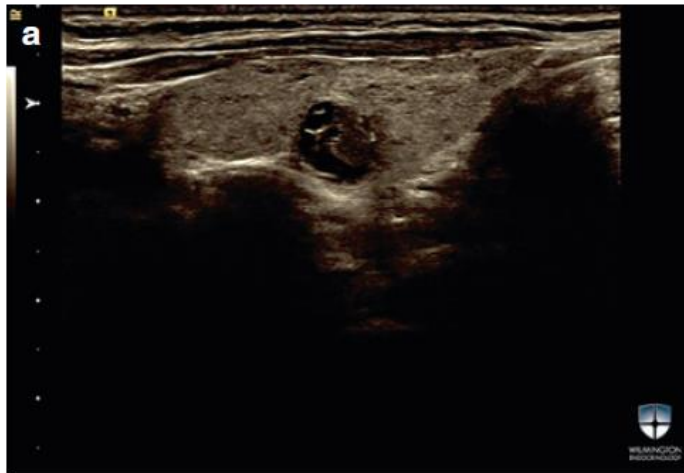
# ELASTOGRAPHY

- Why tumor cells have higher stiffness
  - Increased cellularity
  - Increased tumor nonepithelial cells (fibroblasts, endotelial cells, squamous metaplasia)
  - Increased matrix substances (collagen , calcifications)
    - This effectiveness is due to part of the presence of Psamomma bodies

# STRAIN ELASTOGRAPHY

- FNAB positive for Papillary Thyroid Carcinoma





# PITFALLS

Operator Dependant

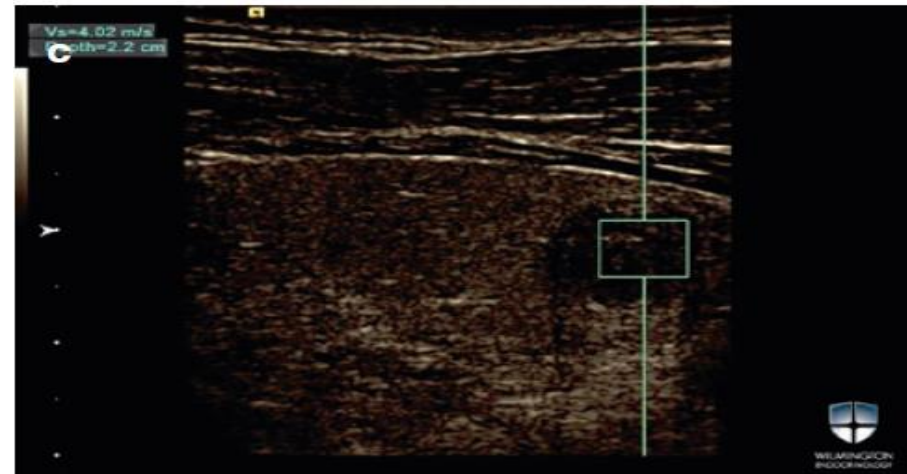
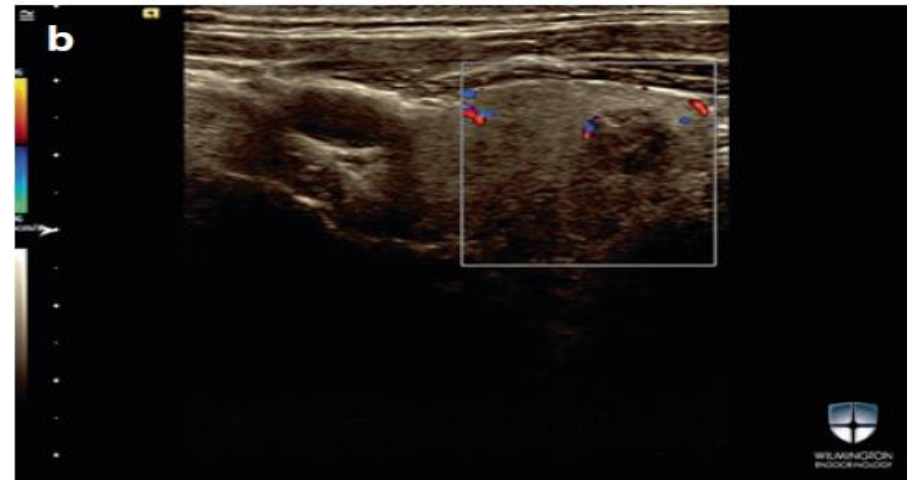
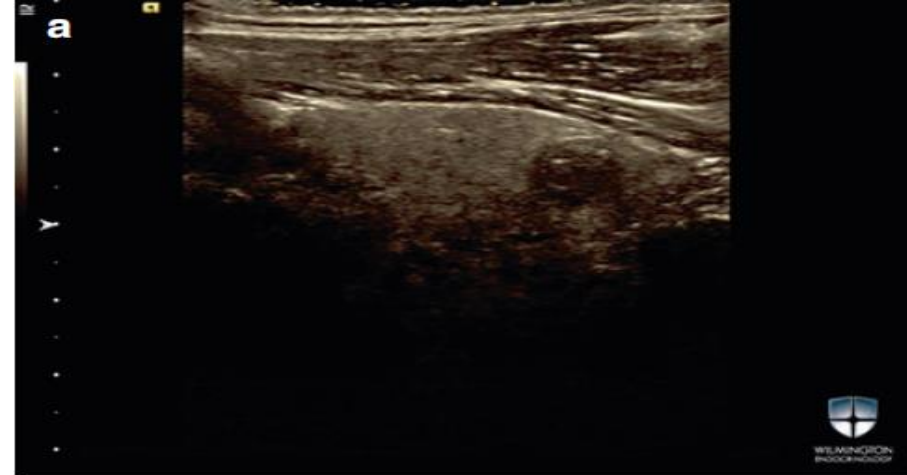
Location thyroid nodule

Presence of thyroid fibrosis  
or heterogeneity



# SHEAR WAVE ELASTOGRAPHY

- In shear wave elastography a separate ultrasound pulse is delivered at an angle to the imaging US waves.
- Unlike strain elastography, shear wave elastography does not require manual compression techniques and it is less operator-dependent.



# PITFALLS

- Shear wave does not exist in fluids.
  - Complex thyroid nodules with high fluid content, with >50% cystic component underperform
- Isthmus location of thyroid nodules, due to proximity to trachea, can produce high shear wave values
- Poor availability
- Calcified nodules provides a higher stiffness value.

# ELASTOGRAPHY

- Strain only provides qualitative images and does not quantify stiffness
- SWE is operator dependant with multiple artifacts.
- No color map guidelines.
- Shear wave elastography with scarce data on thyroid pathology.
- Both technologies may improve our ability to detect thyroid cancer and lead to fewer unnecessary thyroid biopsies and surgeries.
- However, more prospective studies are required to determine the precise value of these new technologies in specific thyroid nodule subgroups.

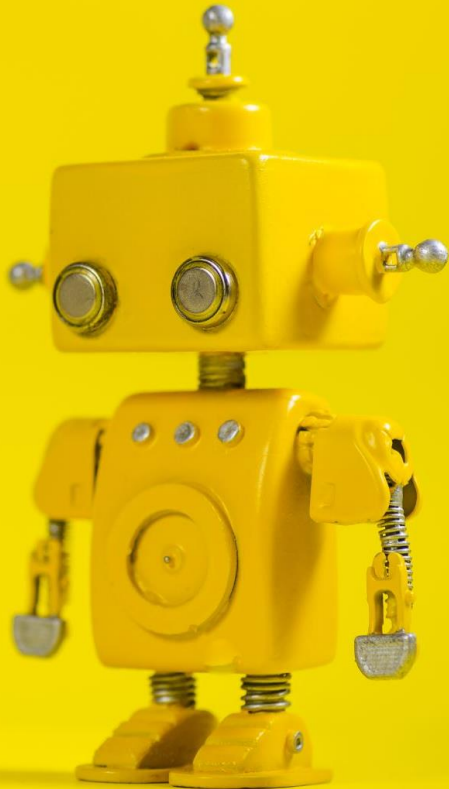


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# ARTIFICIAL INTELLIGENCE

- “Any computational program that stimulates and mimics human intelligence in task such as problema solving and learning”
- Models/algorithms which can solve specific tasks by learning patterns.
- The more data the better.

# ARTIFICIAL INTELLIGENCE



- Machine Learning
  - Supervised
  - Deep Learning
    - unsupervised
- Augmented Intelligence





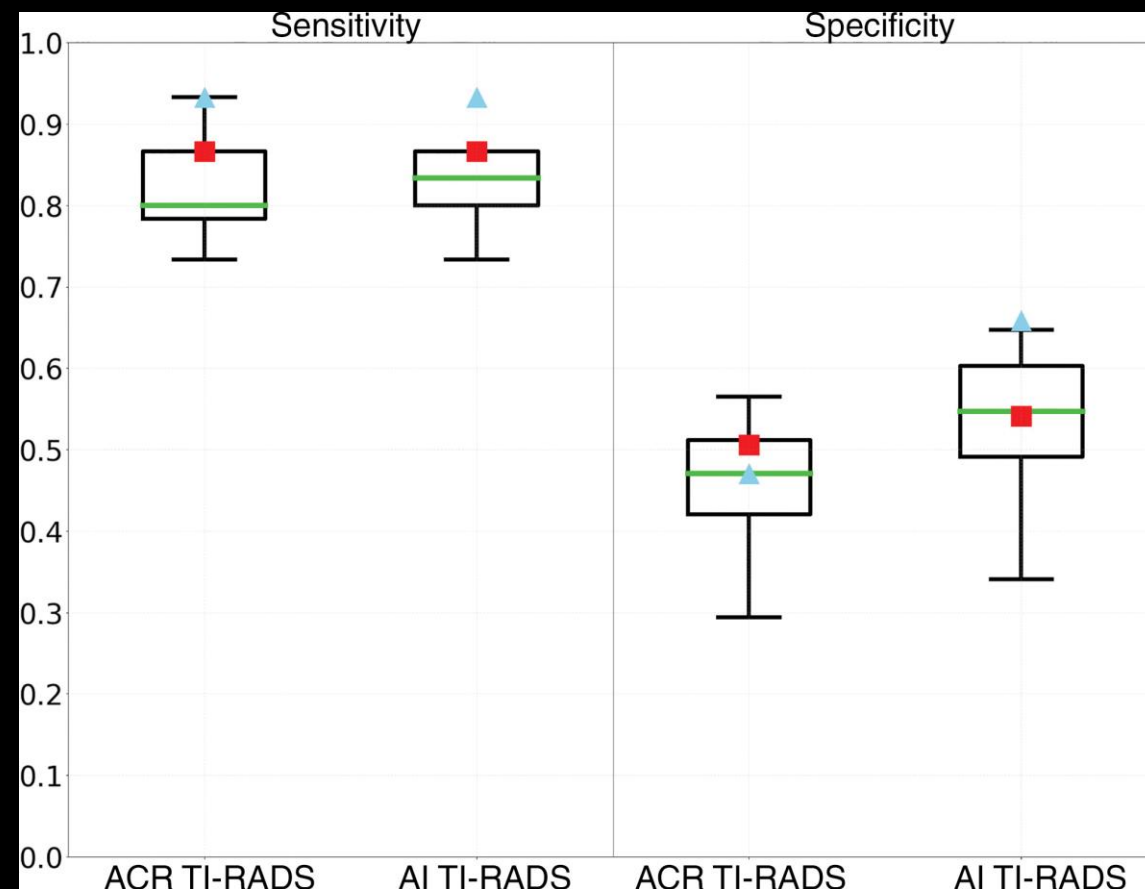
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# ARTIFICIAL INTELLIGENCE

- AI data suggests that it can provide insight to better predict the likelihood of thyroid cancer and to decrease variability during interpretation.
- Whether those findings can successfully be translated to the clinical practice setting and improve patient care is unknown.

Reader	ACR TI-RADS		AI TI-RADS			
	Sensitivity (%)	Specificity (%)	Sensitivity (%)	<i>P</i> Value	Specificity (%)	<i>P</i> Value
Single expert reader	14/15 (93.3) [77.2, 100]	40/85 (47.1) [37.3, 57.1]	14/15 (93.3) [77.2, 100]	NA	55/85 (64.7) [54.5, 74]	< .001
Mean of eight nonexpert readers*	81.7 (62.5, 97.7)	47.7 (36.4, 59.0)	82.5 (64.1, 97.7)	<i>P</i> > .5	55.3 (43.7, 66.6)	< .001
Expert panel consensus	13/15 (86.7) [66.7, 100.0]	43/85 (50.6) [40.3, 61.0]	13/15 (86.7) [66.7, 100.0]	NA	46/85 (54.1) [43.7, 64.6]	.10

## Using Artificial Intelligence to Revise ACR TI-RADS Risk Stratification of Thyroid Nodules: Diagnostic Accuracy and Utility



# COMING SOON...

2021 ATA Guidelines

# SOLID

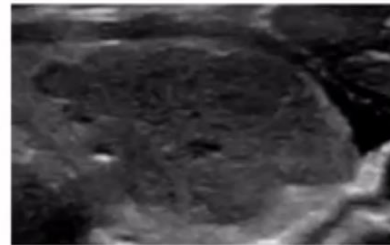
?NON marked hypoechoic solid nodule

## High suspicion

Marked hypo  
+ SF or PEF/Calc

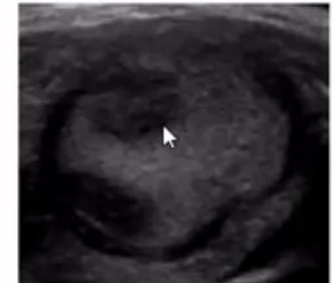
## Intermediate susp

Marked hypo w/o SF  
Any other echogenicity +  
SF or PEF/Calc



## Low suspicion

Any other echo and lacks  
SF or PEF/Calc



PEF-punctate echogenic foci

Suspicious features (SF): TTW shape, lobulated or infiltrative borders, irregular peripheral calcs or suspected ETE



# MIXED

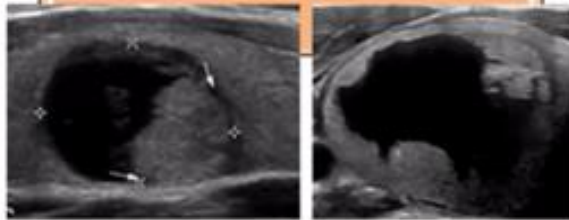
## High suspicion

Solid component jagged/spiculated with PEF/Calcs



## Intermediate susp

Solid component is moderately lobulated or has dominant protrusion



## Low suspicion

solid component is concentric and non-lobulated/smooth



## Very low suspicion

spongiform, nearly entirely cystic

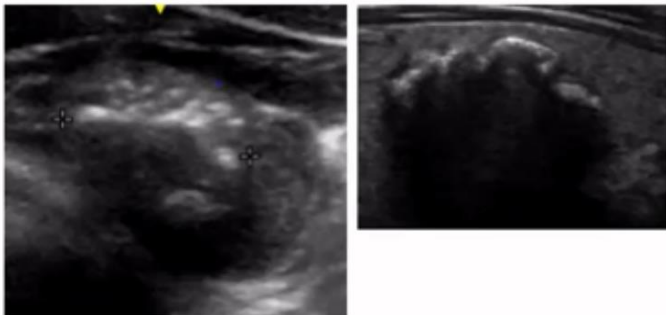
PEF-punctate echogenic foci

Suspicious features (SF): TTW shape, lobulated or infiltrative borders, irregular peripheral calcs or suspected ETE

**Cannot  
Assess**

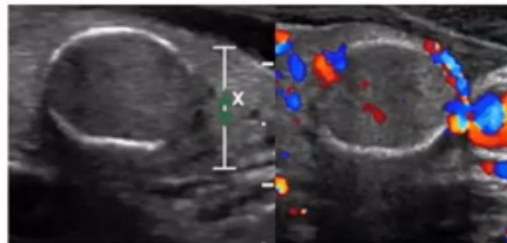
**High suspicion**

nearly entirely calcified or  
irregular peripheral calcs



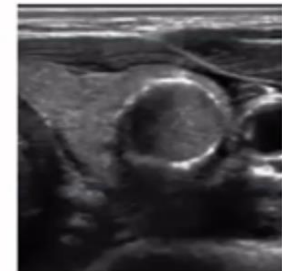
**Intermediate susp**

thin peripheral  
calcifications + internal  
vascular flow;  
suspect solid + markedly  
hypoechoic

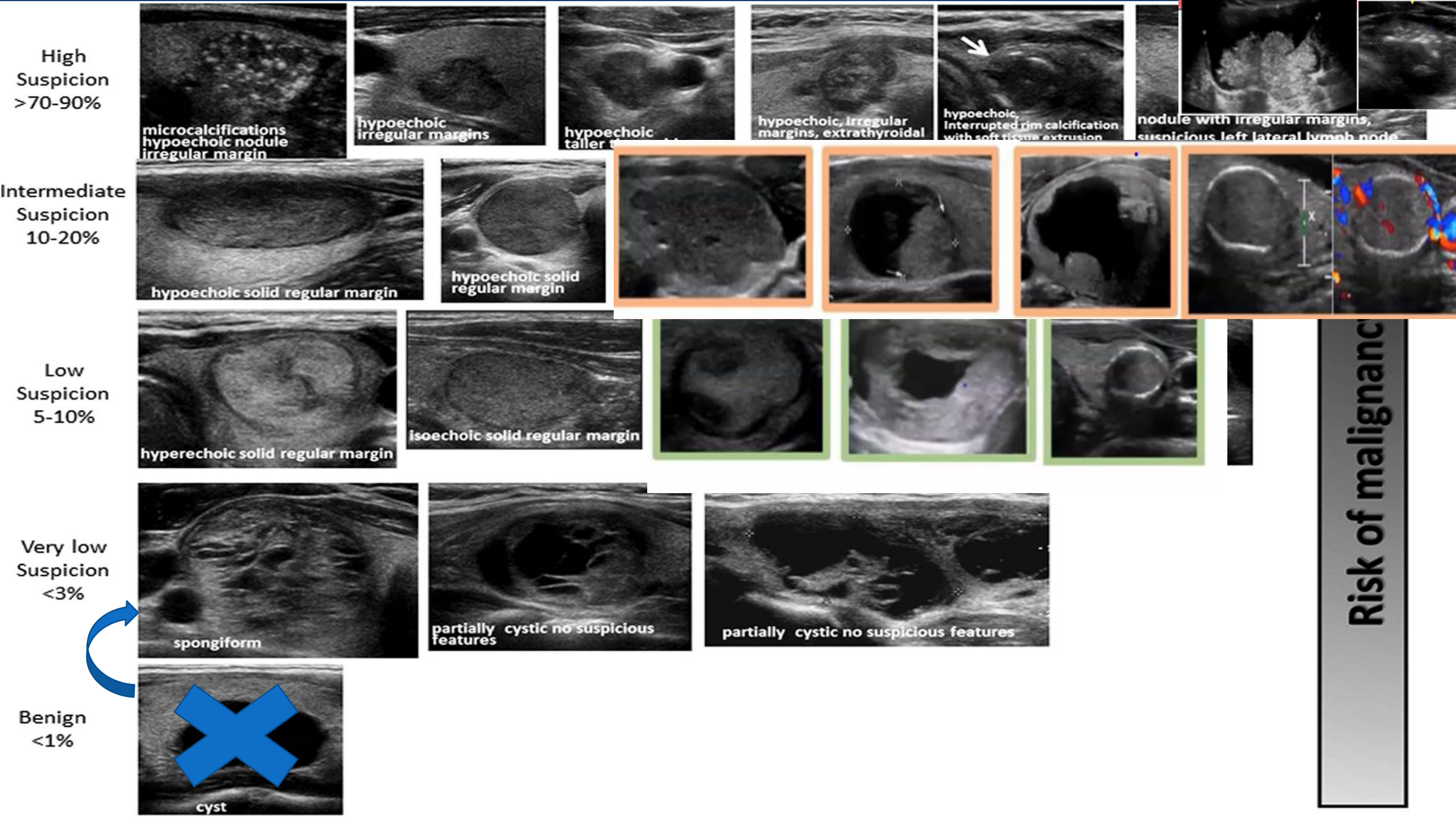


**Low suspicion**

thin peripheral  
calcifications and no  
internal vascular flow;  
suspect not solid









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# COMING SOON.....

- Screening beyond genetic syndromes [Graves, Hashimoto's]
- Special populations
  - Age, comorbidities
  - Transplant patients
- FNA Decision Making
  - Patient risk factors
  - SIZE RANGES
- Bening cytology nodules
  - Non surgical approach [ethanol, radiofrequency ablation]





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# CONCLUSION

- Multiple US RSS can be used for clinical practice
- One size does not fill all
- The future is bright for US technology
- New ATA guidelines Will fill the gap of the unclassified thyroid nodules