



Intranodular echogenic figures

Characteristics of thyroid nodules

T. Solymosi

www.thyrosite.com

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Parts of this topic

1. This power-point presentation
2. Manual in pdf format
3. Lectures describing the various subtypes of echogenic figures
4. Lectures on the differentiation of the subtypes of echogenic figures
5. Edifying cases – video records
6. Quiz for self assessment

Syllabus of this presentation

1. Description of the various subtypes of intranodular echogenic figures
2. The importance of the echogenic figures in the differential diagnostics

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- The deconstruction has only relevance in education.
- In the real world we have to integrate the individual findings.

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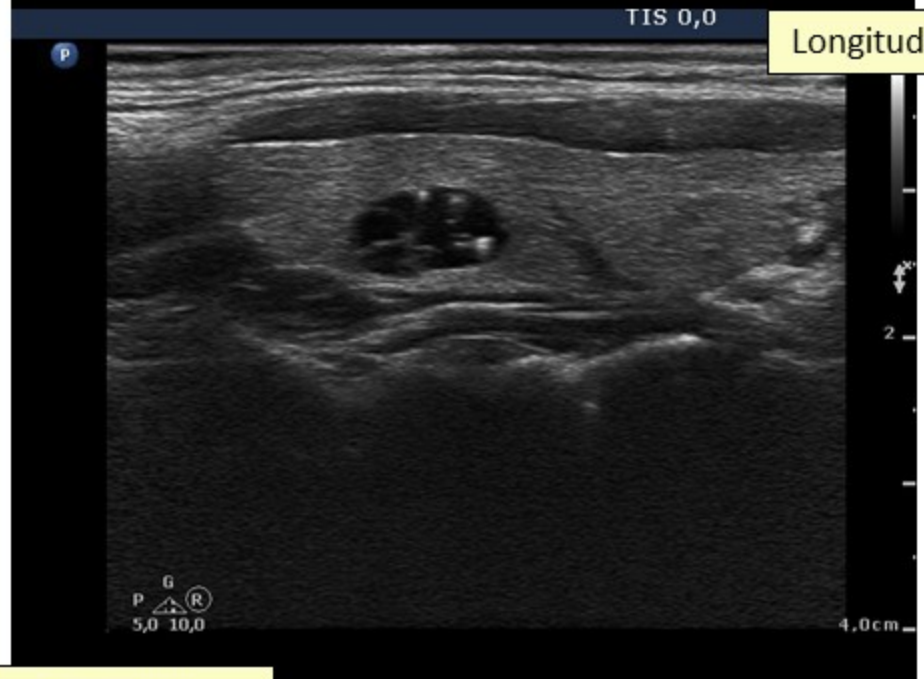
Consideration 2: What we are searching for?

- The very essence of the topic on intranodular figures is the differential diagnostics of microcalcifications.

Horizontal views



Longitudinal views



Case 402

Case 763

Horizontal views



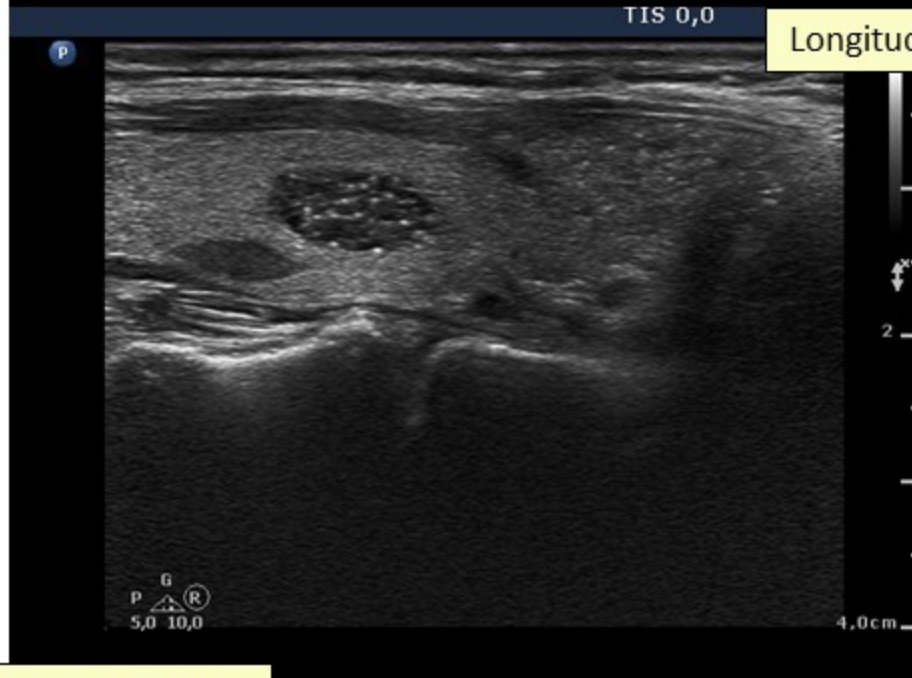
Longitudinal views



Horizontal views



Longitudinal views



Subtypes of intranodular echogenic figures

1. Non-specific echogenic figures
2. Proliferation of connective tissue
3. Comet-tail artifacts
4. Back-wall figures caused by posterior enhancement
5. Punctate echogenic foci (microcalcifications)
6. Macrocalcification
7. Amyloid deposits
8. Granulation around surgical thread



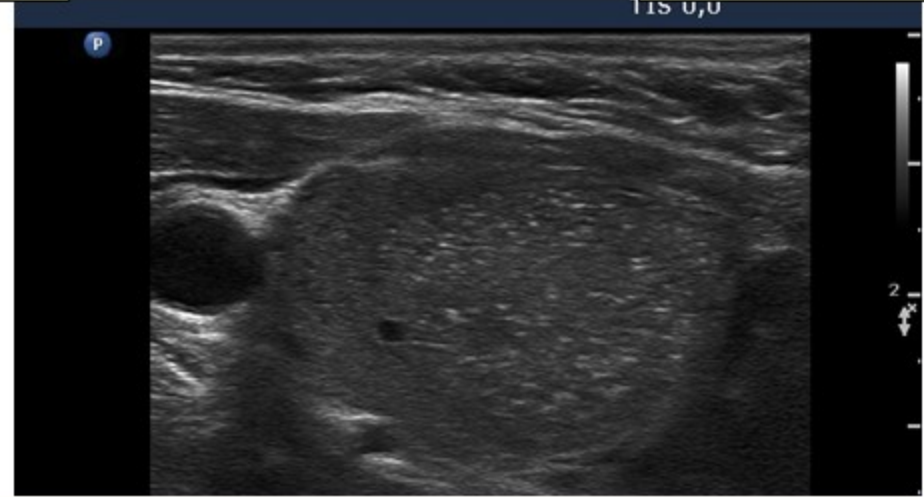
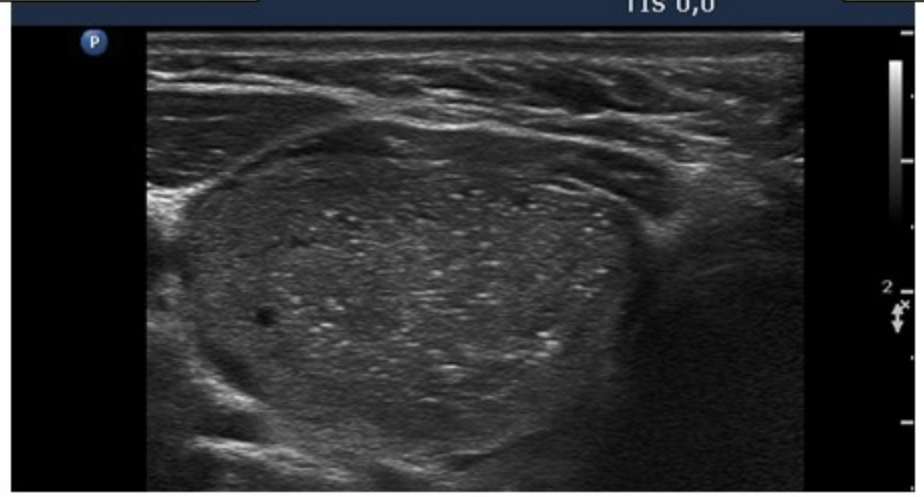
Non-specific hyperechogenic figures

These correspond to the net of thin connective tissue present all along the human body.

These are seen in the form of **synchronous pale lines and granules** depending on the angle between the ultrasound wave and the connective tissue.

In most cases this network is invisible on ultrasound and has no relevance.

The issue is the thickening of this structure in the event of proliferation of connective tissue.



Proliferation of connective tissue

These correspond to the net of thickened connective tissue.

The characteristic feature is the **synchronous presence of bright lines and granules** depending on the angle between the ultrasound wave and the connective tissue.

Thick connective tissue is frequently found in Hashimoto's thyroiditis and to a lesser extent in Graves' disease. Less than 5% of nodules present thick connective tissue.

The relevance of proliferation of connective tissue lies in the differentiation from microcalcifications, both present echogenic granules, but microcalcification does not echogenic lines.



Back-wall cystic figures

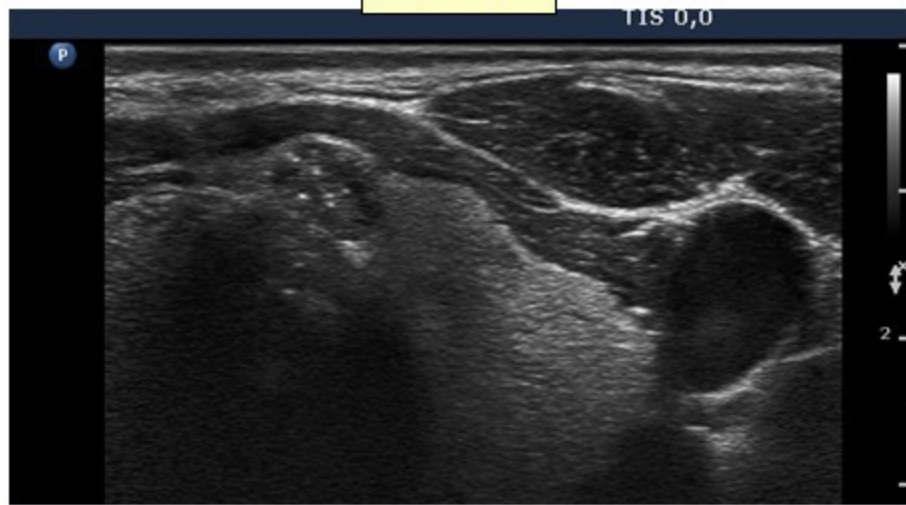
The cause for these figures is the **posterior back-wall enhancement**, an optical phenomenon.

By definition these figures are **bright lines or granules** seen **in the dorsal wall of cystic areas**.

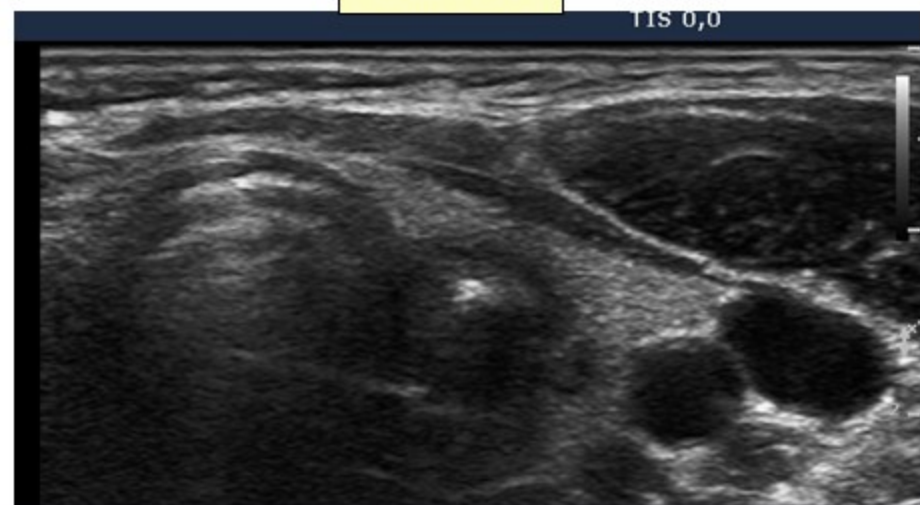
The presence of back-wall cystic figures tend to be occur in benign cystic lesions but the practical relevance is the differentiation from microcalcification.

The issue is the **differentiation from microcalcifications** in tiny and therefore difficult-to-recognize cystic areas.

Case 763



Case 1605



Punctate echogenic foci (microcalcifications)

The terminology is not uniform: 'true micocalcifications' (Russ-2017) and 'punctate echogenic foci' (Tessler-2017) are also used to describe these figures. These include but not exclusively include calcified tips (psammoma bodies) of a papillary fragment seen on histopathology.

By definition these are **bright**, echogenic **granules** with **< 1 mm** in maximal diameter – not infrequently occurring in clusters causing differential diagnostic issue

The presence of microcalcifications **increases the likelihood of papillary carcinoma to 6.8-times** (Campanella-2014). Microcalcifications are found in 17.0 to 75.0% of carcinomas, but also in 2.5% to 33.3% of benign lesions (see Manual). The huge difference in incidences reflects the **significant difference in the interpretation**.

Microcalcifications should be differentiated from comet-tail artifacts and bright granules of connective tissue. This distinction is not always possible.

104611



Case 627



Coarse calcifications

There are various forms of coarse calcifications. Although several of them greatly increase the likelihood of malignancy, these subtypes are very rare.

A **dorsal acoustic shadow** defines the presence of coarse calcification irrespectively of the presence (left image above) or the lack (right image) of the calcified focus.

A coarse calcification is easy to recognize.

The **practical relevance** of coarse calcification in the differential diagnostic is **limited**.

Case 529



Case 1197



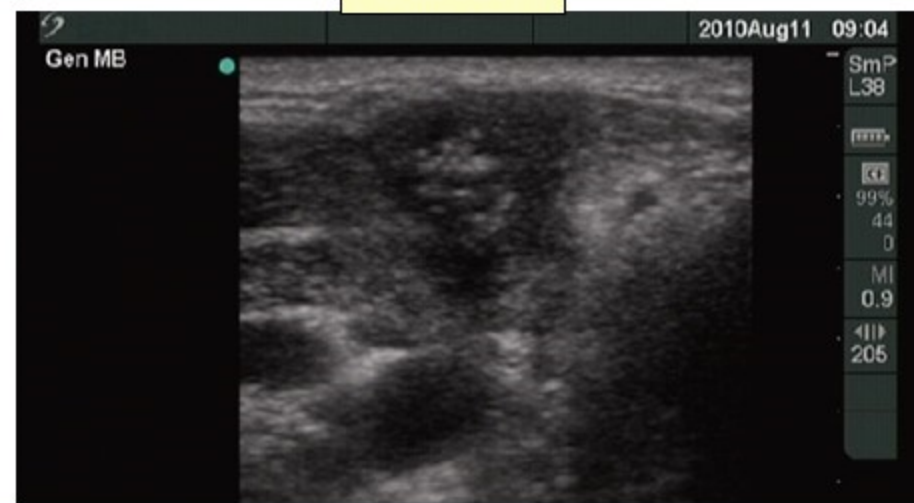
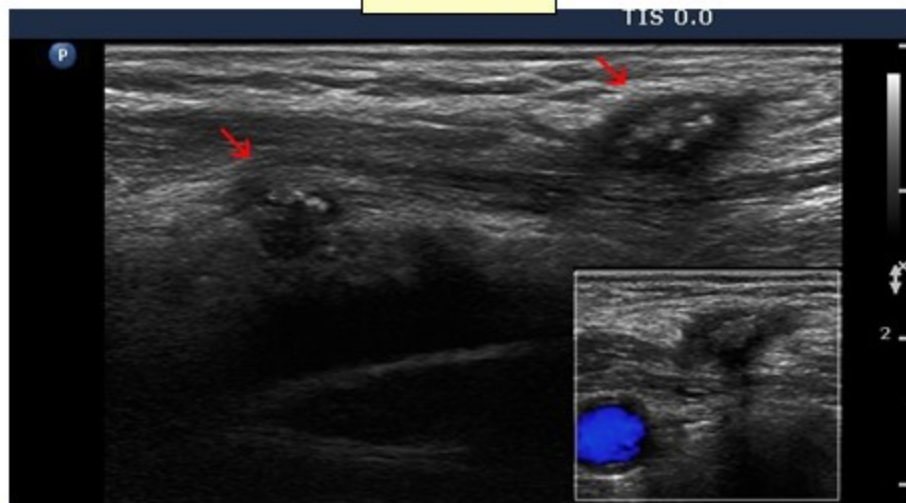
Amyloid deposit

This is only rarely mentioned in the literature although the presence of this figure is quite specific and sensitive for medullary carcinoma.

This is an **echonormal or hyperechogenic, cotton-like patch** of several millimeters **usually having punctate echogenic foci** within a hypoechoic nodule.

We have found this figure in 48% of medullary carcinomas (Solymosi-2013).

The presence of cotton-like echogenic patches in a hypoechoic nodule should raise the possibility of medullary carcinoma, and serum-calcitonin should be measured.



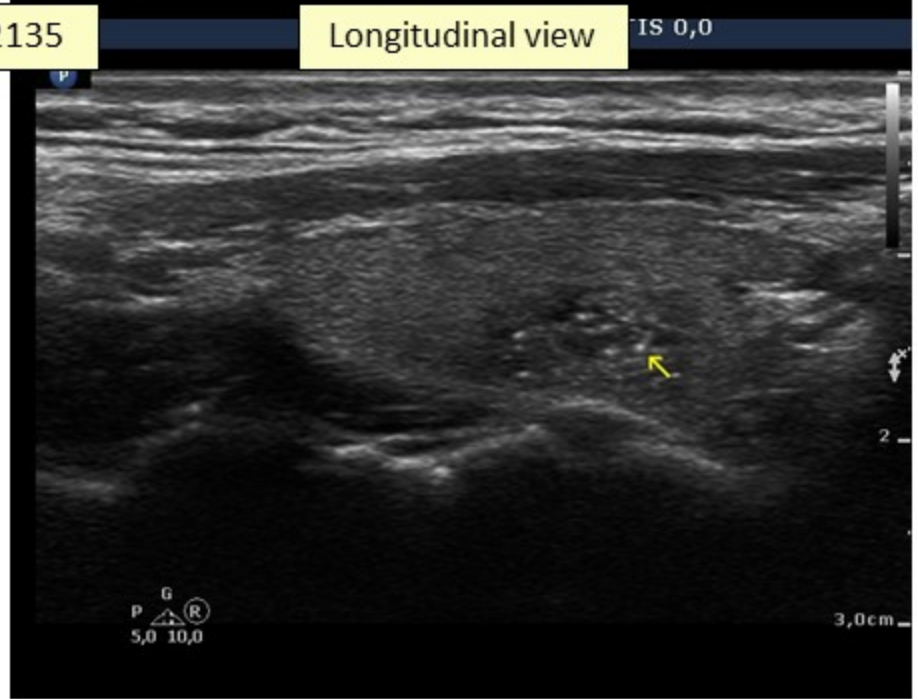
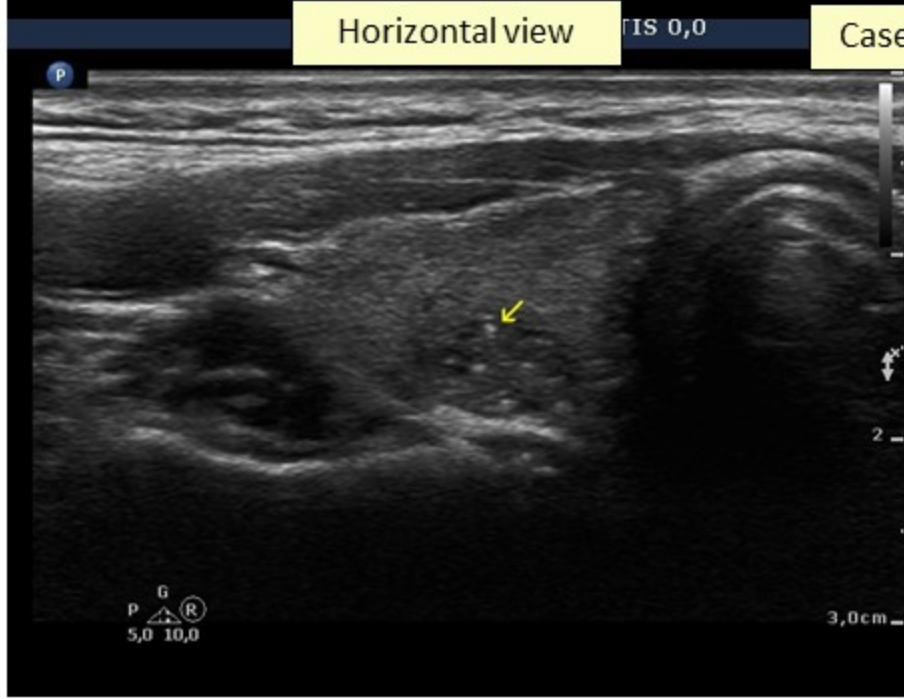
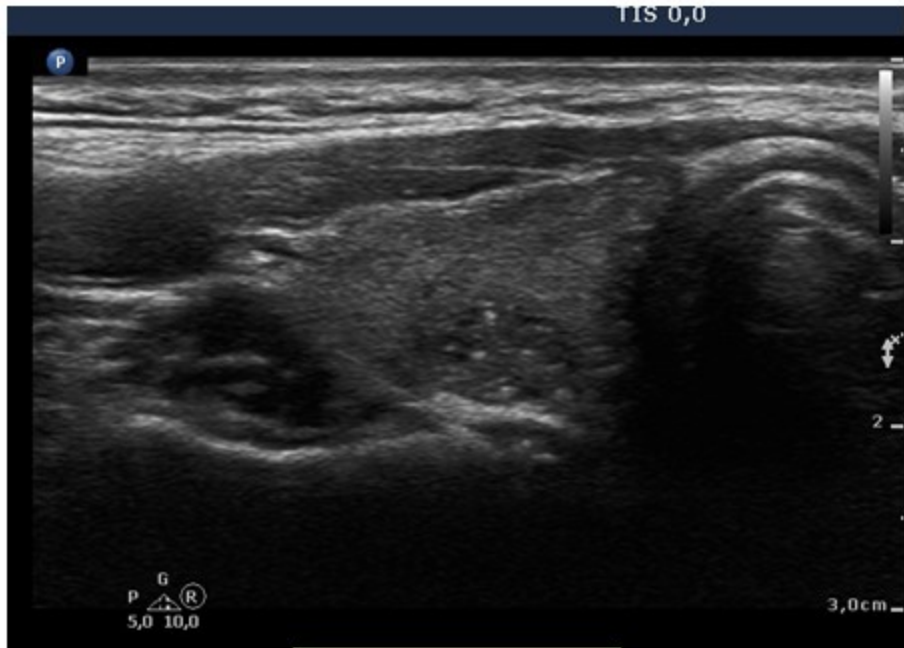
Granulation around surgical thread

This **hard, painless, not infrequently multiple** granulation is a pathological entity which might appear even decades after surgery.

This **hypoechoogenic, irregularly shaped** lesion is **always avascular** and has **echonormal areas with bright echogenic granules**.

If we are aware about the **patient' history**, the diagnosis is easy.

Occasionally it might cause deep concern if it appears decades after a partial resection. If the radiologist is not aware of patient history and faced with a newly developed, hard, irregularly shaped, hypoechoogenic mass having echogenic granulations, the diagnosis could be missed.



Case 2135

The role of intranodular echogenic figures in the differential diagnostics of thyroid nodules

1. Intranodular echogenic figures in the TIRADS systems
2. The occurrence of echogenic figures in thyroid cancers

Handling of echogenic figures in TIRADS systems

1. An overview of the 5 most important classification systems – in the context of the role of intranodular echogenic figures.
2. This time, the goal is not to fully understand the scoring system. TIRADS will be discussed in a distinct chapter.
3. Not to memorize but be aware of the different ways of thinking
4. To pause the video at several points is recommended

Intranodular figures mentioned in TIRADS of professional societies – AACE/ACE-AME

1 Low-risk lesion

- Cysts (fluid component >80%)
- Mostly cystic nodules with reverberating artifacts and not associated with suspicious US signs
- Isoechoic spongiform nodules either confluent or with regular halo

2 Intermediate-risk lesion Slightly hypoechoic or isoechoic nodules, with ovoid shape, smooth or ill-defined margins. May be present:

- intranodular vascularization
- elevated stiffness at elastography
- macro- or continuous rim calcifications
- indeterminate hyperechoic spots

3 High-risk lesion Nodules with at least 1 of the following features:

- Marked hypoechogenicity
- Spiculated or lobulated margins
- Microcalcifications
- Taller-than wide shape
- Extrathyroidal growth
- Pathological adenopathy

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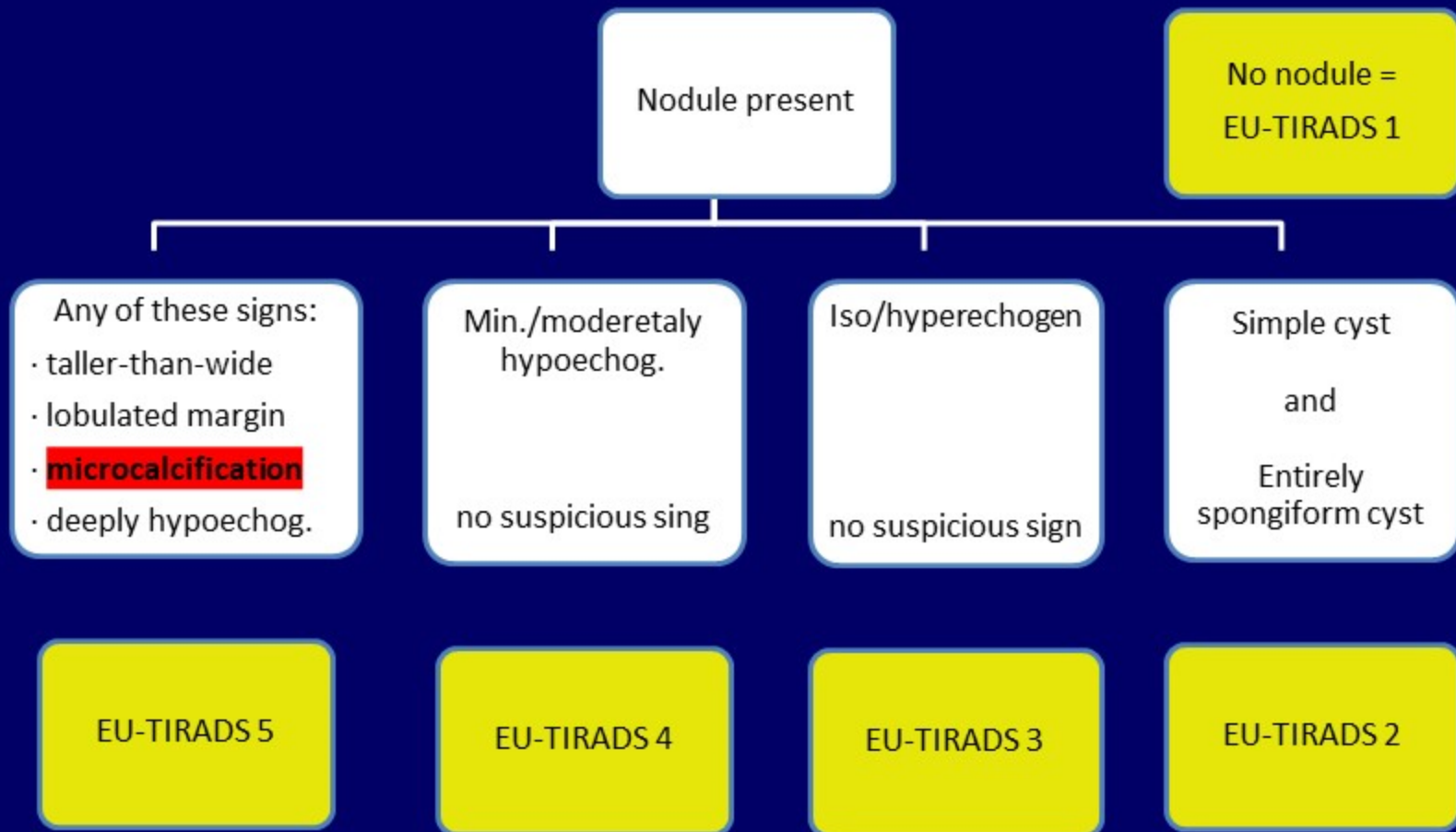
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- Marked hypoechogenicity
- Spiculated or lobulated margins
- **Microcalcifications**
- Taller-than wide shape
- Extrathyroidal growth
- Pathological adenopathy

Intranodular figures mentioned in TIRADS of professional societies – European TIRADS



Intranodular figures mentioned in TIRADS of professional societies – ATA

1 Low-risk lesion Purely cystic nodules (no solid component)

2 Very low suspicion Spongiform or partially cystic nodules without any of the features describes in low-, intermediate- or high-suspicion patterns

3. Low suspicion Isoechoic or hyperechoic solid nodule, or partially cystic nodule with eccentric solid area without:

- Microcalcification
- Irregular margin
- Extrathyroidal extension
- Taller than wide shape

4 Intermediate suspicion Hypoechoic solid nodule with smooth margins without:

- Microcalcification
- Extrathyroidal extension
- Or taller than wide shape

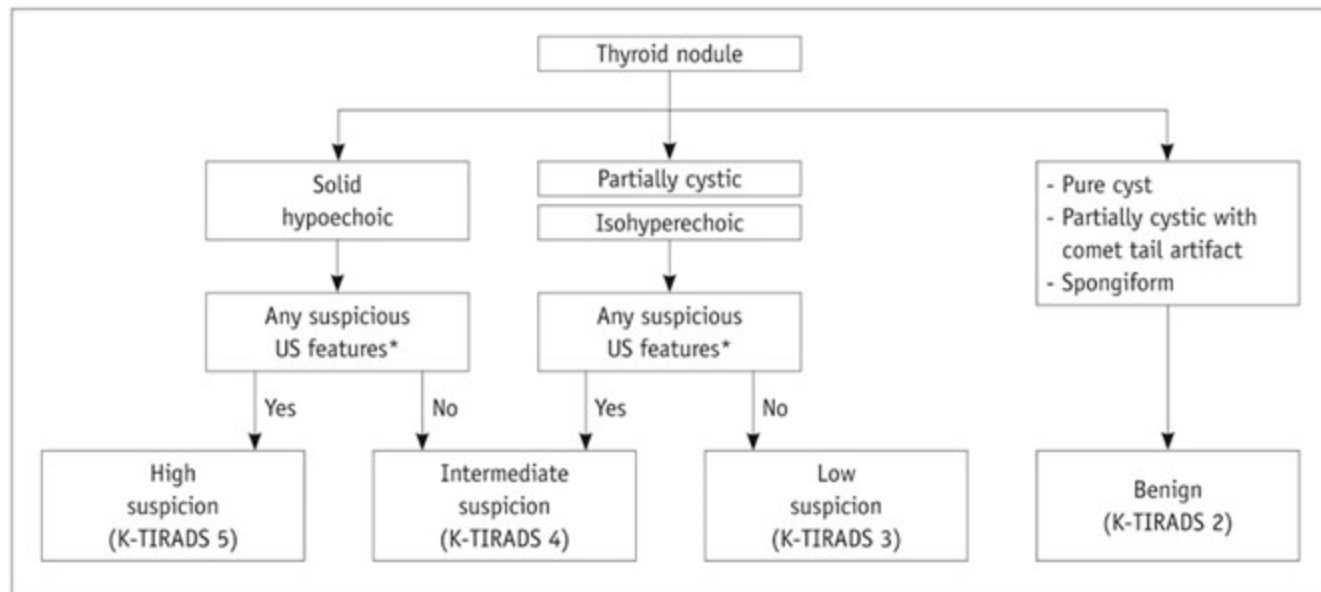
5 High suspicion Solid hypoechoic nodule or solid hypoechoic component of partially cystic nodule with 1 or more of the following features:

- Irregular margins (infiltrative, microlobulated)
- **Microcalcifications**
- Taller than wide shape
- **Rim calcifications with extrusive soft tissue component**
- Evidence of extrathyroidal extension

Intranodular figures mentioned in TIRADS of professional societies – Korean TIRADS

No nodule = K-TIRADS 1

Thyroid nodule = K-TIRADS 2-5



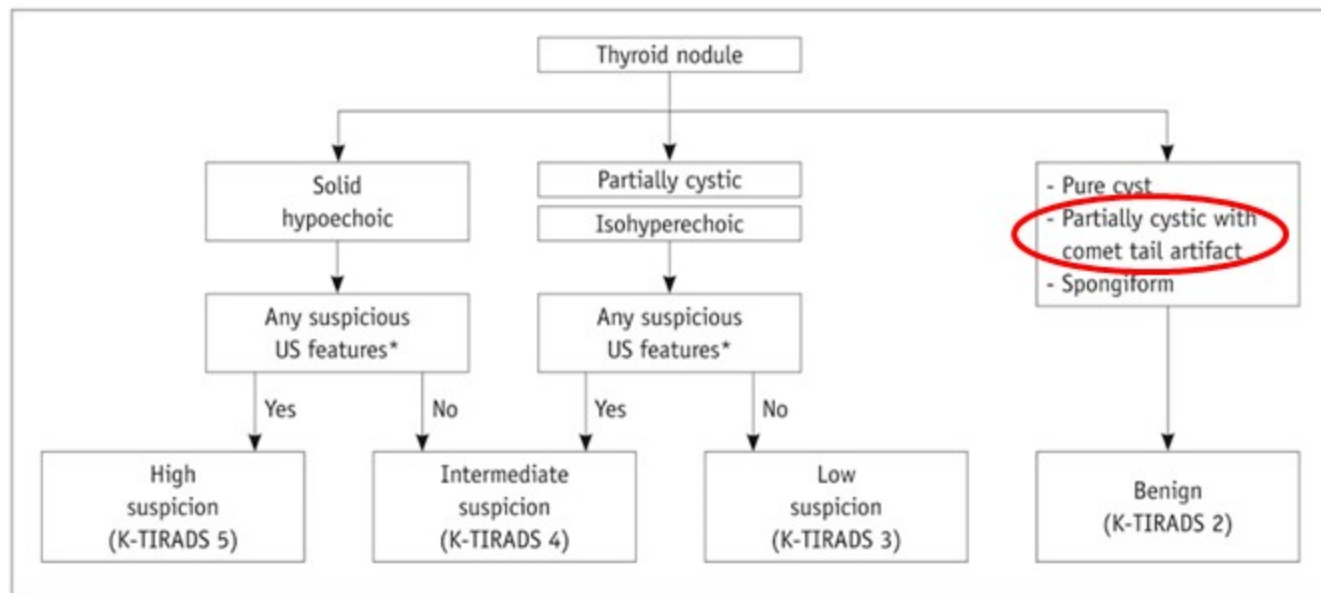
Suspicious US features:

- **microcalcifications**
- taller-than-wide shape
- spiculated/microlobulated margins

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No nodule = K-TIRADS 1

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Suspicious US features:

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Intranodular figures mentioned in TIRADS of professional societies – ACR TIRADS

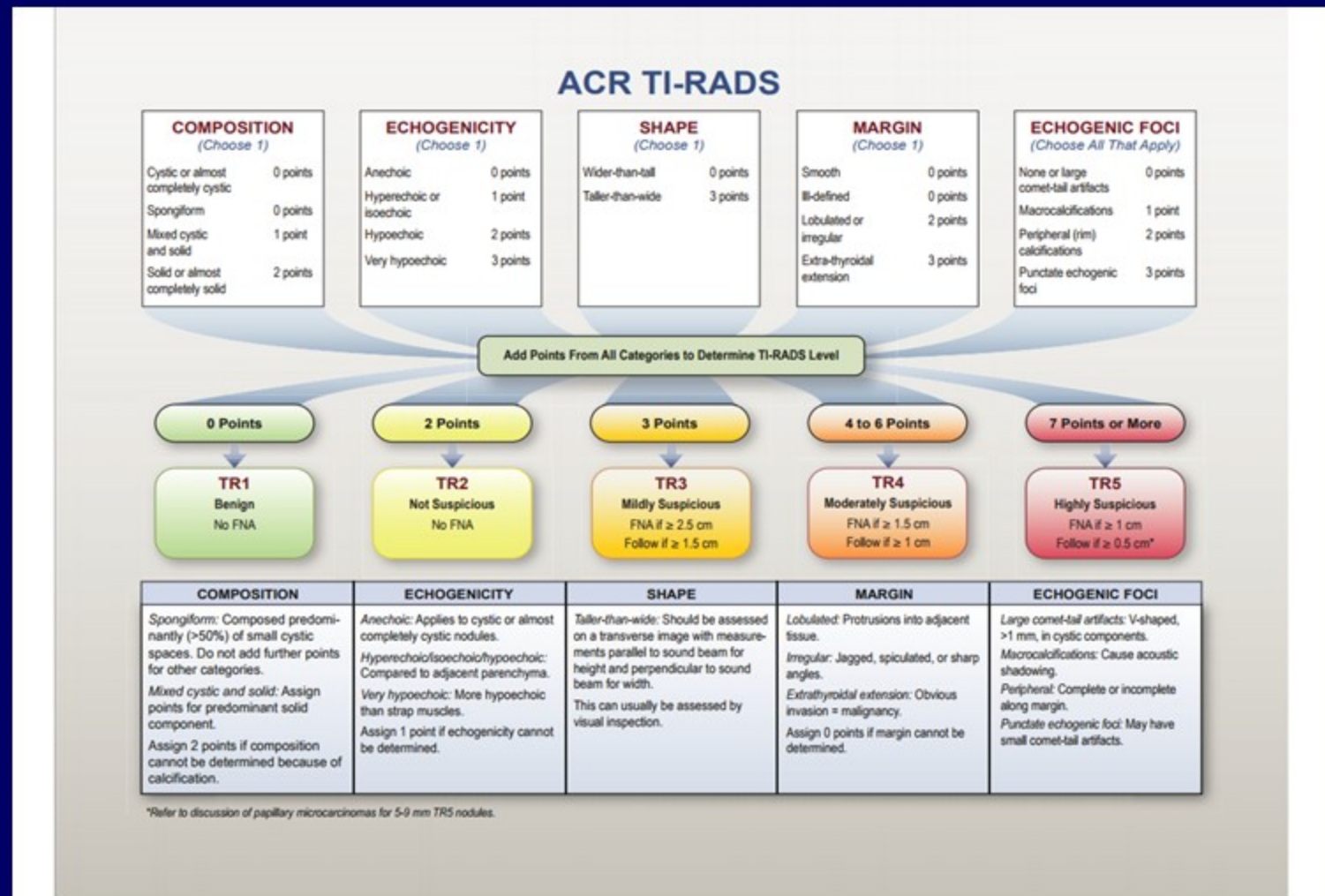


Fig 1. Chart showing five categories on the basis of the ACR Thyroid Imaging, Reporting and Data System (TI-RADS) lexicon, TR levels, and criteria for fine-needle aspiration or follow-up ultrasound. Explanatory notes appear at the bottom.

Intranodular figures mentioned in TIRADS of professional societies – ACR TIRADS

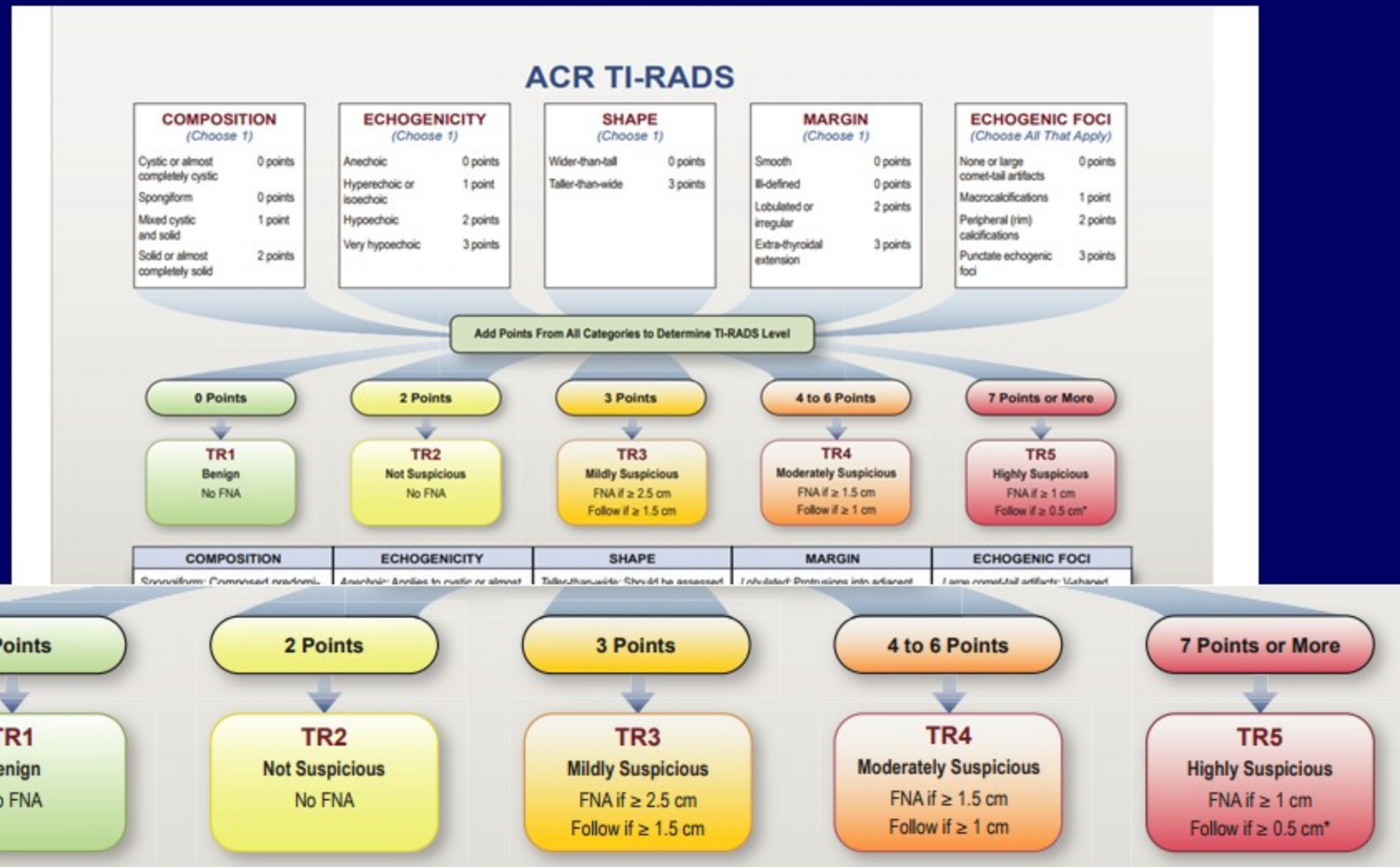


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Intranodular figures mentioned in TIRADS of professional societies – ACR TIRADS

ECHOGENIC FOCI <i>(Choose All That Apply)</i>	
None or large comet-tail artifacts	0 points
Macrocalcifications	1 point
Peripheral (rim) calcifications	2 points
Punctate echogenic foci	3 points

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



Intranodular figures mentioned in TIRADS of professional societies – ACR TIRADS

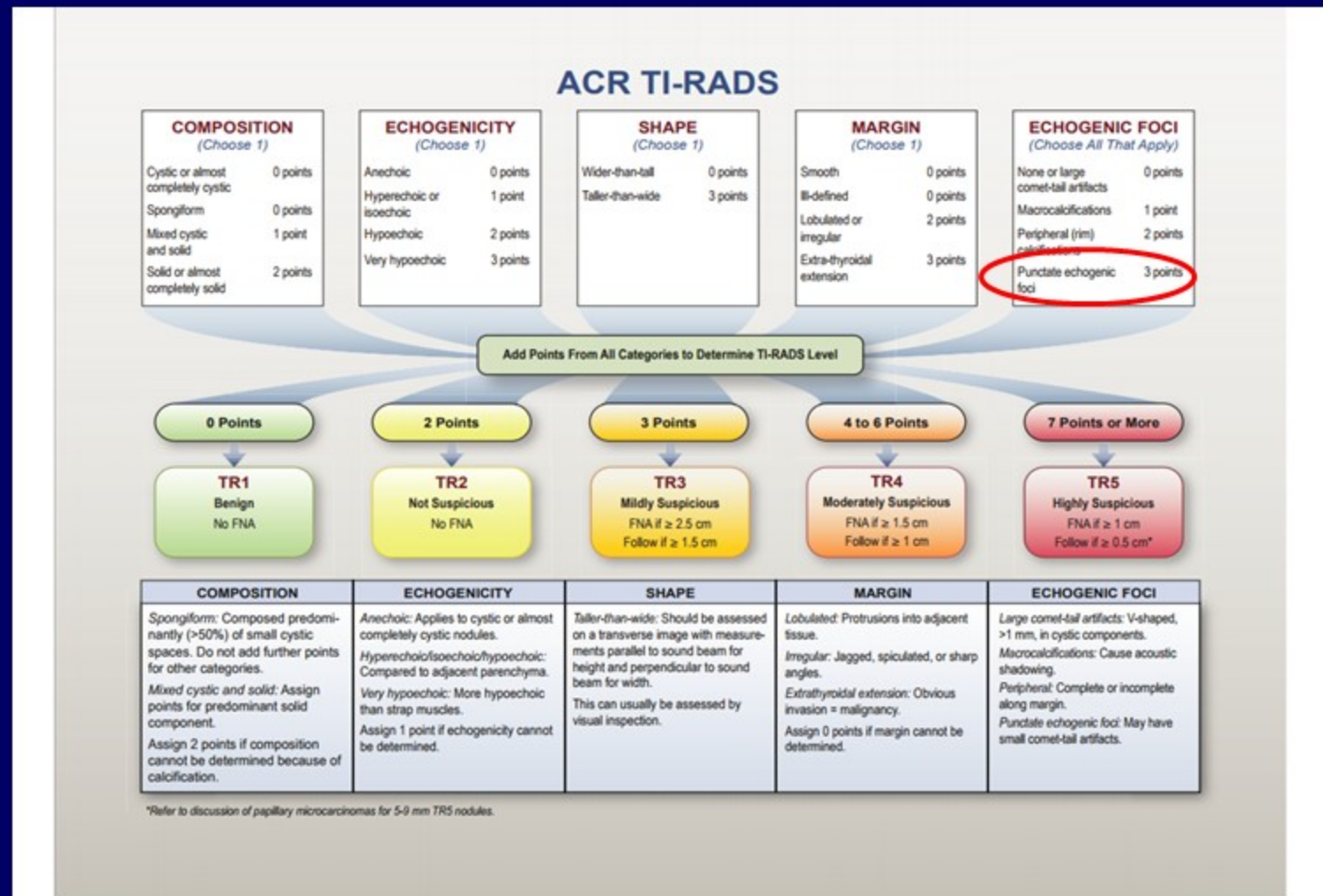


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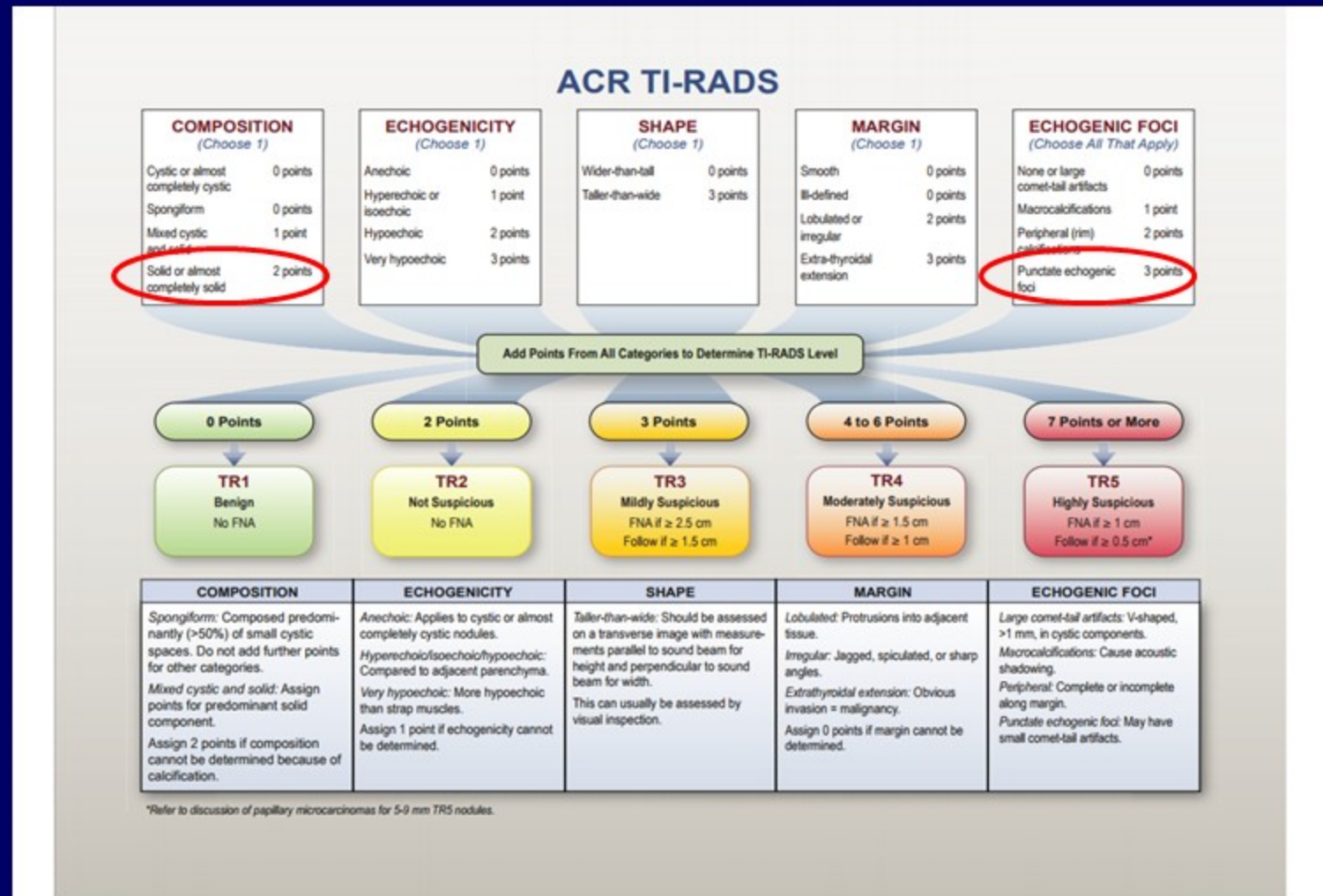


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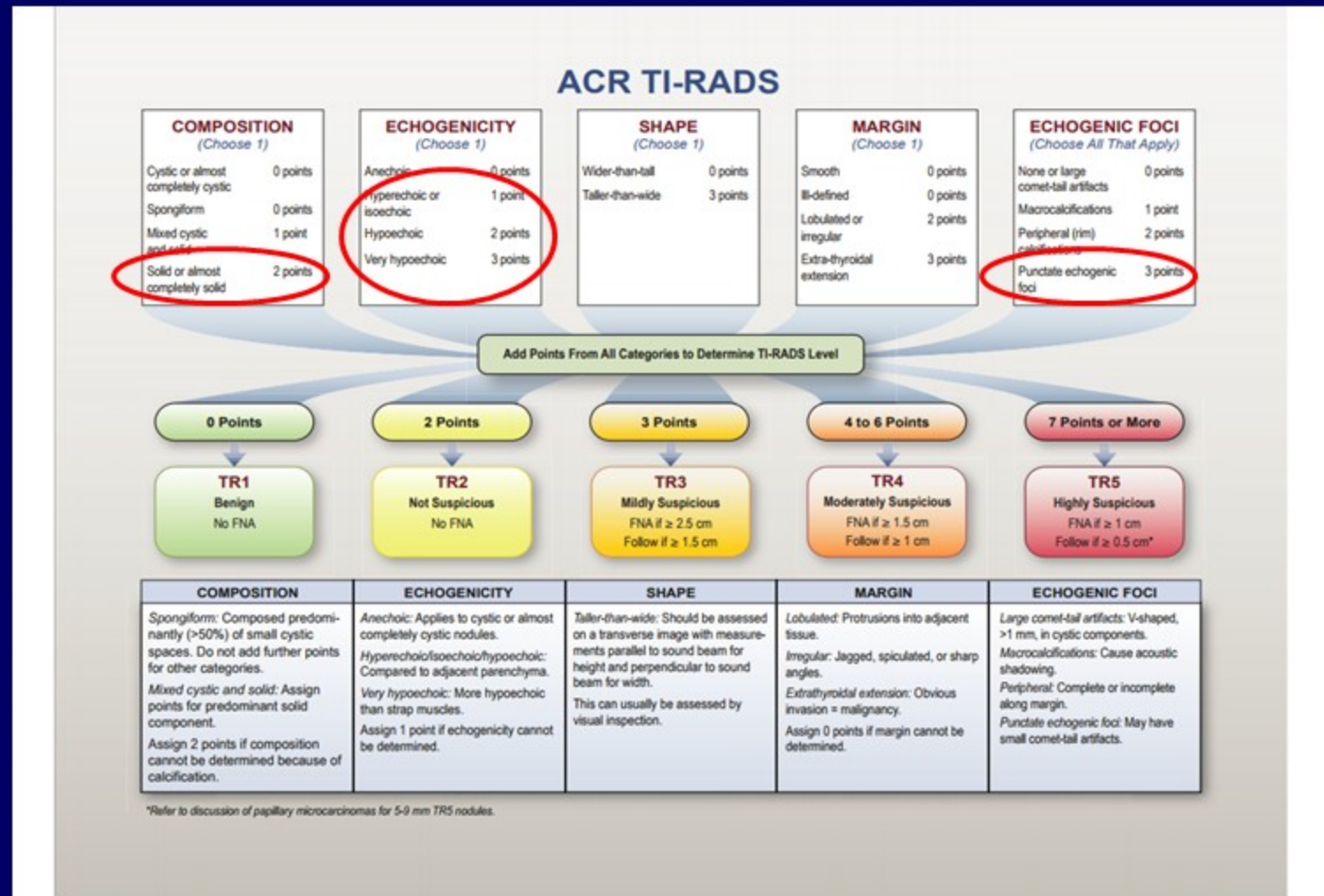


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The role of **comet tail artifact** in classification of thyroid nodules in the 5 TIRADS

1. Has NO influence in AACE, ACR, ATA, European TIRADS

2. Has influence in Korean TIRADS

in partially cystic nodules without suspicious signs (around 40% of nodules)

low risk if comet tail artifact is NOT present

- diagnostic FNA is recommended in nodule > 15 mm

benign if comet tail artifact is present

- diagnostic FNA is not recommended.

The role of **macrocalcification** in classification of thyroid nodules in the 5 TIRADS

1. Has NO influence in AACE, ETA, Korean TIRADS

2. ATA TIRADS

- **Rim calcifications with extrusive soft tissue component** is included among suspicious signs which in itself classify the nodule as most suspicious
- Affects less than 1% of all nodules.

3. ACR TIRADS

- **Peripheral rim calcification** is treated similarly to universally accepted suspicious findings
- Affects around 5% of all nodules.

The role of **microcalcification** in classification of thyroid nodules in the 5 TIRADS

	AACE	ETA	ATA	Korean	ACR
Non-hypoechoic	High suspicion		Intermediate suspicion		Intermediate or high
Hypoechoic			High suspicion		

Interobserver variation, validation of microcalcifications

1. No biological standard to which compare the feature

—————→ the role of consensual interpretation

—————→ the basis of this is the uniform, strict definition

Interobserver variation, validation of microcalcifications

1. No biological standard to which compare the feature
2. The quality of definition can hardly be improved in microcalcification
 - Punctate, bright echogenic granule < 1 mm in the solid part
Lack of similarly bright echogenic lines

The occurrence of microcalcifications in surgically treated patients - metaanalysis

	Benign lesions		Malignant lesions	
	microcalcification present/all	(%)	microcalcification present/all	(%)
Kim et al (2002)	15/106	14.2	29/49	59.1
Papini et al. (2002)	15/371	4.0	9/31	29.0
Capelli et al. (2006)	mostly FNA dg.	28.7	mostly FNA dg.	72.2
Gulcelik et al. (2008)	3/72	4.2	16/26	61.5
Salmaslioglu et al. (2008)	82/1633	5.0	261/293	89.1
Popovicz et al. (2009)	32/1045	3.1	25/96	26.0
Sharma et al. (2011)	17/51	33.3	12/16	75.0
Ozel et al. (2012)	6/341	1.8	10/22	45.5
Solymosi et al. (2015)	291/7180	4.1	70/411	17.0
Zayedeen et al. (2016)	51/2002	2.5	30/148	20.3
All – median (range)		4.1 (1.8-28.7)		52.3 (17.0-89.1)

Interobserver variation, validation of microcalcifications

1. No biological standard to which compare the feature
2. The quality of definition can hardly be improved in microcalcification
3. ACR speaks not about microcalcifications but punctate echogenic foci
 - Microcalcification and short comet tail artifact in solid part
 - Considers the difficulty of correct judging of echogenic granules
 - Cannot solve the problem

Interobserver variation, validation of microcalcifications

1. No biological standard to which compare the feature
2. The quality of definition can hardly be improved in microcalcification
3. ACR speaks not about microcalcifications but punctate echogenic foci
4. Concern about TIRADS scoring
 - no room for uncertainty
forces the examiner to give yes and no answers even when it is not possible
 - ethical consequences
 - we pretend colleagues with no or low experience
 - professional consequence
 - TIRADS score is not exact enough to be the basis of the decision on FNA

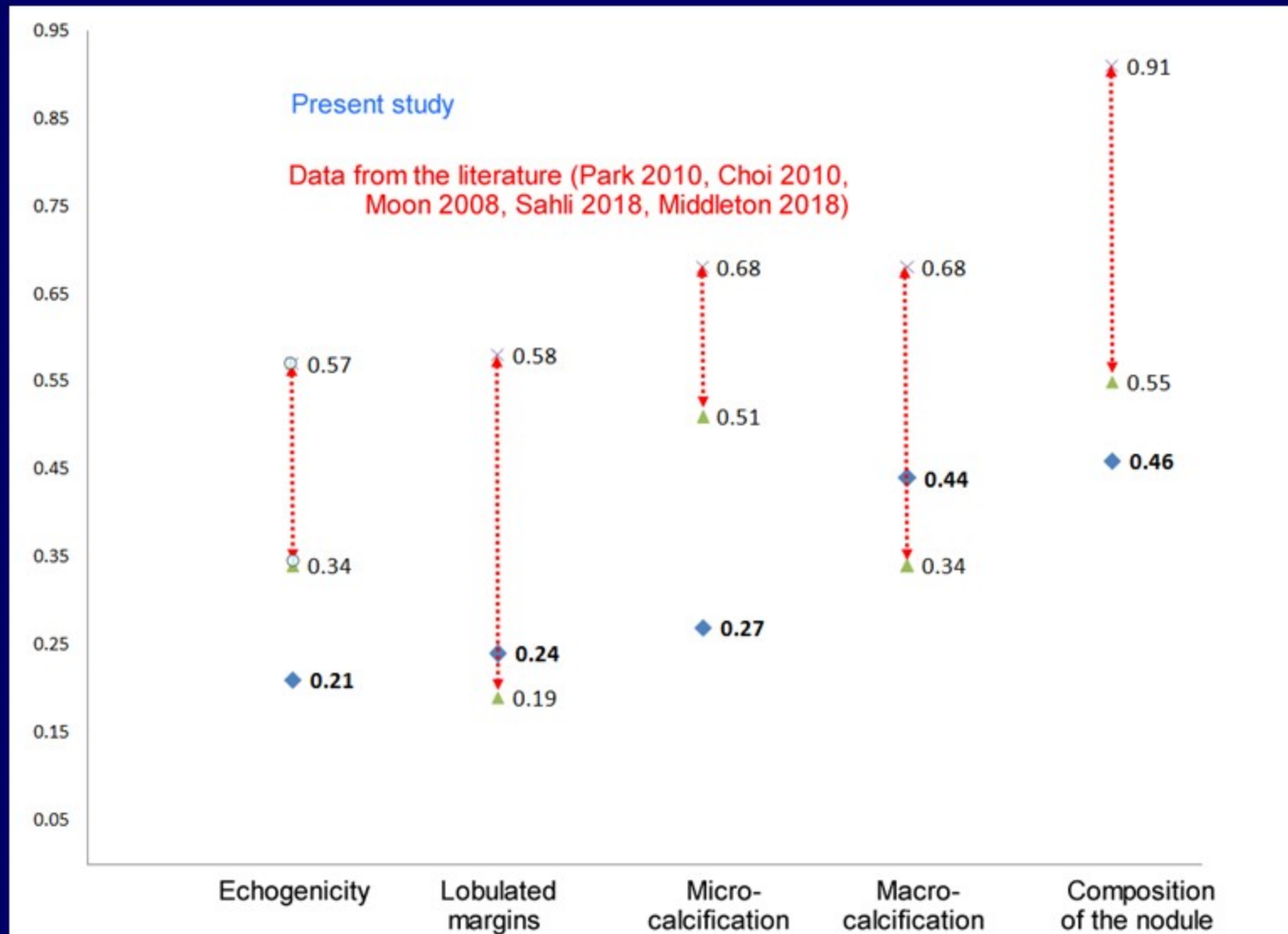
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4. Concern about TIRADS scoring
5. A possible solution for unequivocal figures
 - Don't allow yourself to be forced into unprofessional judgement, but instead, describe your real opinion (e.g. suspicious for microcalcification)
 - Regarding FNA' indication, treat the case as if microcalcification would be really present

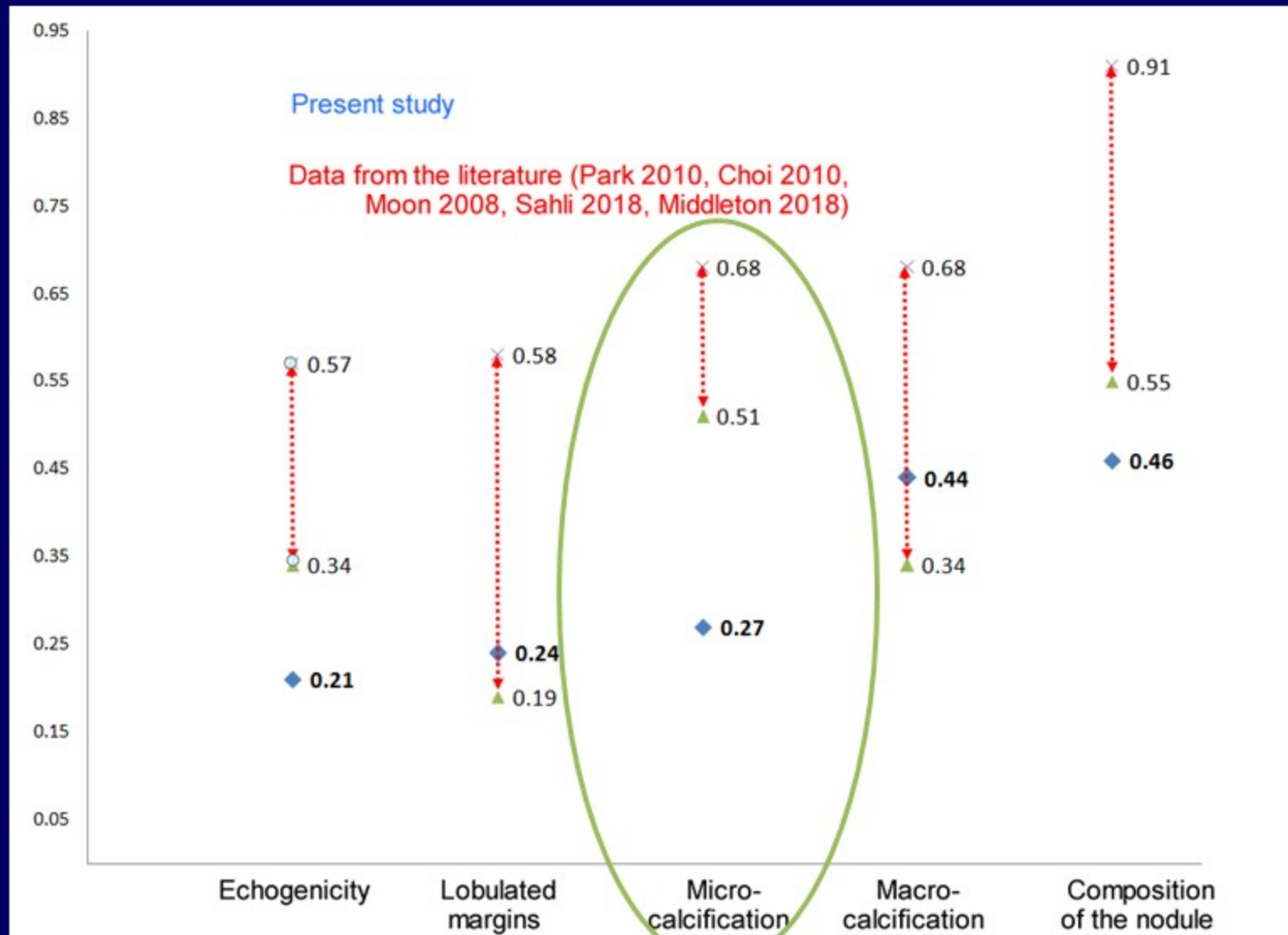
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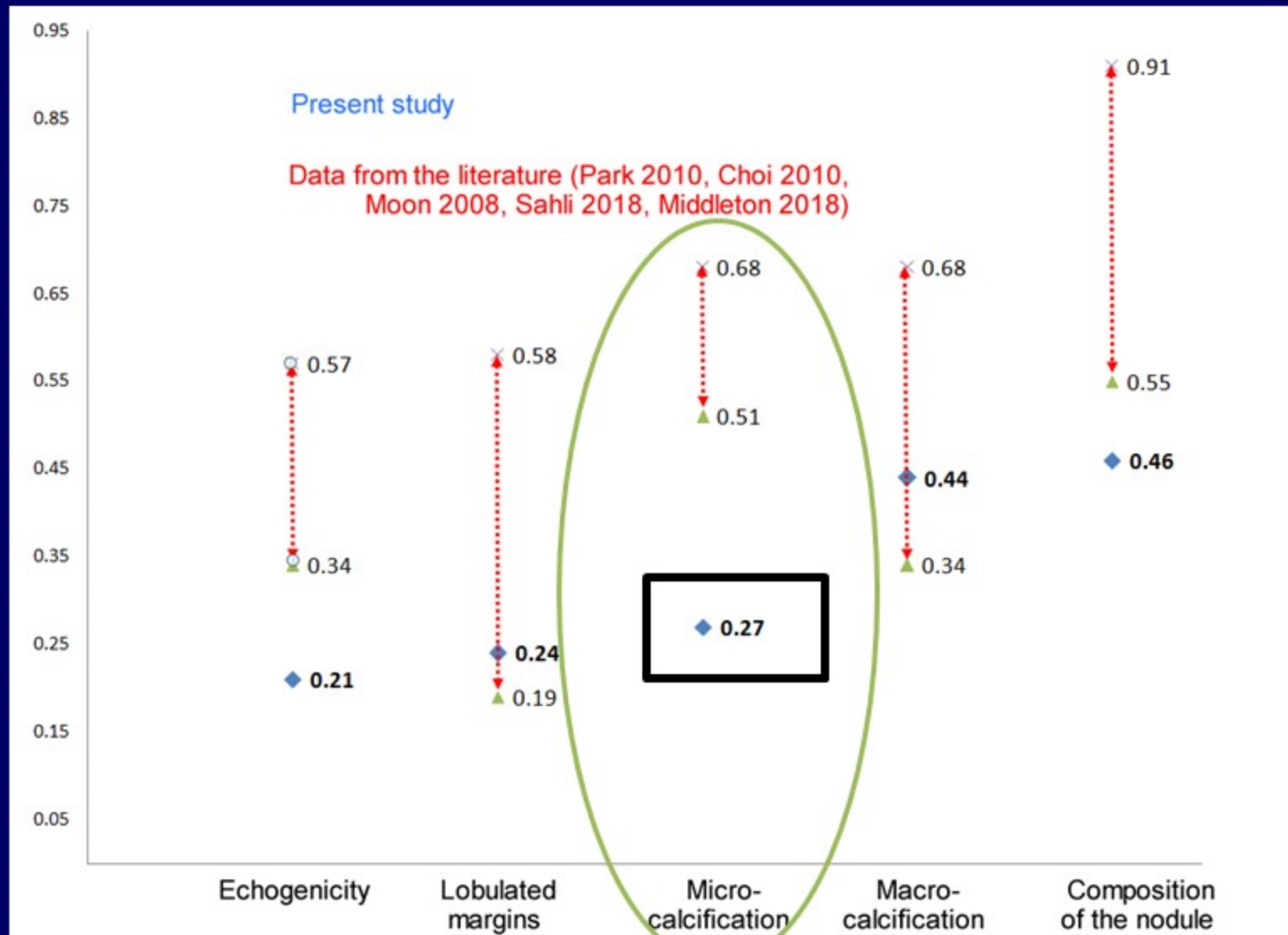
Observer variation in interpretation of certain ultrasound features (*kappa* values)



Observer variation in interpretation of certain ultrasound features (*kappa* values)

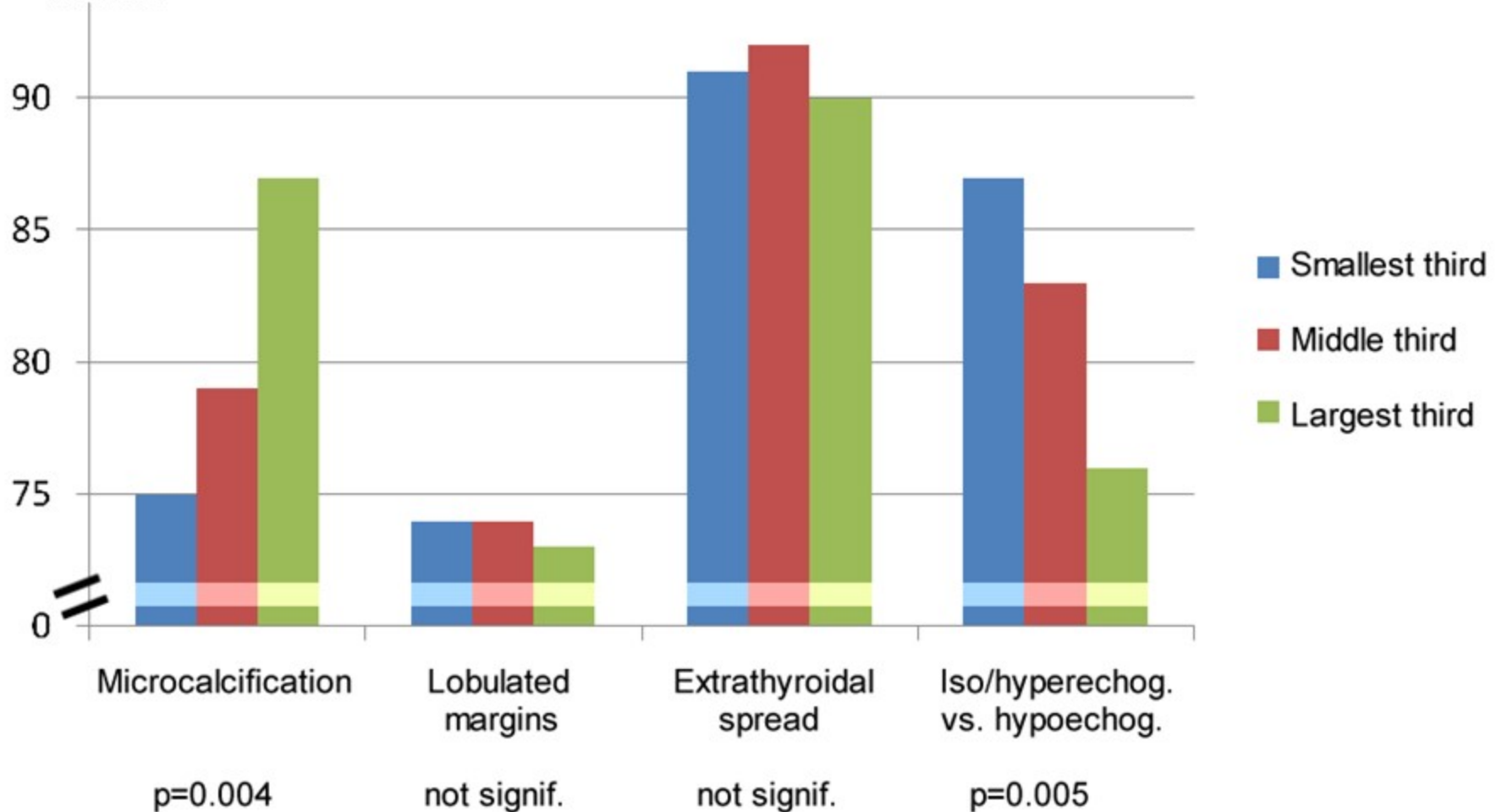


Observer variation in interpretation of certain ultrasound features (*kappa* values)



The influence of nodule size on the interobserver agreement

% of concordant answers



Occurrence of microcalcification in various subtypes of thyroid cancers

	Occurrence – range (%)	Occurrence – median (%)
Follicular	0.0 – 25.5	3.6
Medullary	16.7 – 69.2	45.2
Papillary	17.8 – 80.0	50.9

For references see Manual.

Intranodular figures and medical report of thyroid ultrasound examination

Which echogenic figures have to be described?

- **Bright echogenic granules – compulsory to describe**
 - either presenting microcalcifications or comet-tail artifacts or connective tissue
- **Macrocalcifications** – highly advised to describe
- Hyperechogenic lines without echogenic granules – can be abandoned in a medical report

How to describe echogenic granules?

- The phrase **microcalcification should be restricted to unequivocal forms**
- **Equivocal cases involving the possibility of microcalcifications**
 - Describe the uncertainty or use the phrase 'punctate echogenic foci'

Summary

Microcalcification is the echogenic figure searched for.

Microcalcification is not the public enemy, this is only one characteristic of the public enemy, presented even by benign lesions.

Although the definition of microcalcification is quite uniform, there are significant differences in the interpretation of microcalcification even among highly experienced investigators. Consider the lack of an unequivocal biological standard.

Video and not still image is the base of a real examination and therefore video should be also the base of learning.