Standard Sonographic Report for Thyroid nodules

F. Shirani, MD

Assistant Professor of Radiology

Arak university of medical sciences

Thyroid nodules are commonly detected by high-resolution ultrasound with a prevalence of 19–67%.

While most of these nodules are benign, thyroid cancer is found in **5–15%** of cases. Therefore, their clinical significance relies on the ability to discriminate between benign and malignant lesions. As the likelihood of malignancy is greatly influenced by sonographic features, ultrasound has proven to be a significant tool in the initial evaluation, malignant risk stratification, and long-term management of thyroid nodules.

The key role it plays in making clinical decisions is highly dependent on informative, easily interpreted reports provided by experienced, knowledgeable physicians.

The negative impact of incomplete reporting on cytological diagnosis and surgical intervention has been documented.

Use of a structured reporting template improved the quality of reports significantly.

Tools to standardize reporting have been developed such as the Thyroid Imaging Reporting and Data System **(TIRADS),** and then modified by others over the last decade. Additionally, the ATA and AACE guidelines provide specific features that should, at a minimum, be documented in reports.

All these guidelines, differences notwithstanding, agree on the principle that **all thyroid ultrasound reports should explicitly describe features that inform decision-making**. To date, and despite these efforts, the general adoption of any comprehensive reporting tool seems to be a challenge, and reporting in many instances continues to follow subjective personal preferences.

This is evidenced by a tremendous rise in the estimated risk of malignancy for a solid hypoechoic nodule from 10–20% to > 70–90% if at least one additional feature, such as micro calcification, taller-than-wide shape, or irregular margin, was reported as absent or present, respectively.

Furthermore, since different studies favored different criteria as better predictors of malignancy, the more features reported the better is the distinction between benign and malignant lesions

The primary purpose of sonographic analysis of thyroid nodules is to determine whether a nodule requires fine-needle aspiration (FNA), sonographic follow-up, or no further evaluation.

Although strong trends are based on sonographic features, it is not possible to predict with absolute certainty whether a nodule is benign or malignant.

The goal in managing nodules is to maximize the detection of clinically significant cancers while minimizing the need for FNA of benign nodules.

Certain features of thyroid nodules on ultrasound are consistently predictive of malignancy and are used as criteria for FNA. These criteria have various sensitivity and specificity, but unfortunately none of them alone is sufficient to discard or detect malignancy efficiently. Furthermore, there is substantial interobserver variation in the assessment and reporting of some of the US patterns.

The features with the highest diagnostic odds ratio for predicting malignancy were a “taller-than-wide” shape and internal calcifications , while a spongiform and a cystic appearance most reliably predicted benignity.

A **standardized and systematic description of US features** of thyroid lesions makes the reports objective and more comparable over time. Moreover, a systematic report reduces the possibility of missing the description of some important thyroid lesions features.

Therefore, if possible, US reports should always document *position*, *extracapsular relationships*, *number* and the following characteristics of each lesion: *shape, internal content, echogenicity, echotexture, presence of calcifications, margins, vascularity, hardness, and size.*

Position

The exact location of each nodule within the thyroid gland should always be described in US reports. Thyroid US usually permits a clear identification of an isthmus and of two lobes. Schematically, each thyroid lobe can be virtually divided into three portions: **one third superior , one third medium , one third inferior** and each portion can be further subdivided into two sub-portions: **anterior and posterior** . Isthmus can be divided into: right paraisthmic , left paraisthmic and central part .

Seldom, thyroid nodules are located in the pyramidal lobe and more rarely they can be ectopic. Careful attention should be placed on nodules placed near the thyroid capsule. The systematic description of the thyroid nodule position is useful exclusively in monitoring the lesion during the follow-up. The localization of a thyroid lesion has no diagnostic importance in distinguishing between benign and malignant nodules.

Extracapsular Relationships

Extracapsular relationships of nodules placed near the thyroid capsule should be carefully described. Operators should observe whether the nodule deforms, infiltrates or even crosses the thyroid capsule invading the nearby structures. Therefore, it is important to distinguish simple deformation from infiltration of thyroid capsule, and to describe a possible invasion of the extracapsular areas for a presurgical US tumor staging (T of TNM) of thyroid cancer.

The thyroid capsule may be simply deformed by nodules without interruption of its hyperechogenicity. Deformation of the capsule does not indicate malignancy but it can be useful in assessing possible compression of adjacent structures. Infiltration of the thyroid capsule, instead, is defined as an interruption of its hyperechogenicity at the level of the tumor. This finding is always indicative of malignancy but does not necessarily mean an invasion of surrounding structures. A clear US interruption of the capsule **does not always** correspond to extrathyroidal extension (T3) at postsurgical histological evaluation, indicating that US probably may overestimate tumor staging (T) in the TNM classification.

Number

It has been shown that the risk of malignancy in a multinodular thyroid gland compared to a gland with a solitary thyroid nodule is similar . Therefore, ideally, each nodule should be listed and analytically described. In clinical practice, instead, two exceptions may be granted when several thyroid lesions are present. First, when there are **coalescent thyroid lesions** not clearly distinguishable and a detailed characterization of each nodule is impossible to perform. Second, in case of **clearly distinguishable thyroid lesions, with benign or probably benign features,** when a detailed description of all nodules can result wearisome or may divert from more suspicious lesions. In these cases we suggest to particularly focus on lesions classifiable as malignant, suspicious for malignancy or borderline that should always be described in detail. The remaining lesions classifiable as benign or probably benign should be only listed indicating exclusively their position and size, but avoiding their overdetailed description.

This approach is aimed to obtain clear and streamlined reports but containing all the information on the most suspicious lesions. In all other situations, a careful notation and description of each thyroid nodule is always recommended.

Shape

Based on their shape, thyroid nodules can be classified as: **ovoid** (anteroposterior diameter of a nodule less than its transverse diameter) , **round** (when the anteroposterior diameter is equal to its transverse diameter) , **taller-than-wide** (when the anteroposterior diameter is longer than its transverse diameter) or **irregular** (when a nodule is neither ovoid/ round nor taller-than-wide) .

Both ovoid shape and round shape are reported in benign lesions but they do not obviously exclude malignancy. Instead, a taller-than-wide shape, is reported to be associated with thyroid malignancy . These findings reflect that malignant nodules grow across the normal tissue plane in a centrifugal and antigravitational way, in contrast to benign nodules usually growing along the tissue plane in a parallel fashion . A nodule with irregular shape may be a malignant lesion, but irregular shape can also be noticed in benign conditions, such as focal thyroiditis .

Internal Content

The internal conten can be classified following terminology : **solid** (liquid portion ≤ 10% of the nodule volume) , **mixed predominantly solid** (liquid portion >10% but ≤ 50%) , **mixed predominantly cystic** (liquid portion >50% but ≤ 90%), **cystic** (liquid portion >90%), and **spongiform** (more than half of the nodule volume characterized by aggregation of multiple microcystic areas (<5 mm) separated by thin septations that are interspersed within solid tissue) .

Cystic nodules can be described as **pure cysts** (if without internal septa) or as **polyconcamerated cysts** (if with one or more internal septa); predominantly solid or predominantly cystic nodule, instead, can also be called complex nodules . In general, pure cystic lesions are always thought to be benign; on the contrary, polyconcamerated cysts and complex nodules may harbor a risk of malignancy . In pure cystic lesions, fluid usually appears homogeneously anechoic, with through transmission of sound waves and posterior acoustic enhancement. It usually consists of colloid and sometimes the sound wave interaction with the condensed colloid proteins may result in bright hyperechoic reverberation artifacts (i.e. comet tails) that may be useful in distinguishing the nature of the fluid. A single comet tail artifact within a small cyst is usually called cat’s eye artifact ’ .

In complex nodules, the fluid component may be the result of degeneration or hemorrhage. In these cases, it may change over time as the hematoma resolves, appearing isoechoic or hypoechoic, sometimes raising doubt as to whether the internal content is liquid or solid. Absence of blood flow is usually, but not always, helpful in this distinction. In the presence of internal solid components, distinguishing internal debris from viable tissue, which may present the same gray-scale imaging, is very important. In fact, the first are usually the result of organization processes, are always benign and should not be aspirated for diagnosis.

On the contrary, the solid component of complex nodules composed of viable tissues may harbor a 3% risk of malignancy and therefore they require more attention.

Malignant US features of the solid component of complex nodules reported by literature include: an eccentric configuration, microlobulated or irregular free margins, microcalcifications within a solid component, perinodular infiltration, and a centripetal vascularity in the pedicle.

Echogenicity

The normal thyroid tissue is homogeneously hyperechoic and brighter than the surrounding muscles. Echogenicity of a thyroid nodule should always be referred to the brightness of **its solid component** in comparison with the thyroid parenchyma . When the solid component of a nodule presents different degrees of echogenicity, the overall nodular echogenicity should be defined by that of the majority of the nodule. Based on echogenicity a thyroid lesion can be classified as: markedly hypoechoic (nodule hypoechoic relative to the adjacent strap muscles), hypoechoic (nodule hypoechoic relative to the thyroid parenchyma) , isoechoic (nodule with the same echogenicity as that of the thyroid parenchyma) , hyperechoic (nodule more echoic than thyroid parenchyma) , and anechoic (in cystic lesions with fluid content with through transmission of sound waves).

Pure cysts are always benign and appear anechoic. Hypoechogenicity, instead, is seldom reported in thyroid malignancies. Hypoechogenicity may represent a typical feature of benign nodular fibrosis and in fact almost a third of benign thyroid lesions are hypoechoic too. On the contrary, marked hypoechogenicity seems to be highly specific for malignant nodules. It follows that particular attention should be placed on markedly hypoechoic lesions.

Presence of Calcifications

Calcifications may occur in up to a third of thyroid, both benign and malignant, nodules, and are defined as prominent echogenic foci on US, with or without posterior shadowing. Calcifications should be classified in: microcalcifications , macro calcifications and peripheral rim calcifications (also called ‘eggshell’ calcifications). The type of calcification should always be specified in the US reports.

Microcalcifications appear as small (<1 mm) intranodular punctate hyperechoic spots without posterior acoustic shadowing. Sometimes distinguishing microcalcifications from a benign punctuate echogenic foci may be difficult. Reverberation artifacts due to colloid materials, i.e. comet tails, can be helpful in differential diagnosis. Microcalcifications are thought to represent the calcified psammoma bodies of papillary thyroid cancer and are highly specific for thyroid cancer.

They are usually within malignant well-defined nodular thyroid lesions, but sometimes thyroid papillary carcinomas may also appear as a shaded area of grouped micro calcifications with no evidence of a clear nodular lesion.

Macrocalcifications are coarse and large calcifications (>1 mm) that cause posterior acoustic shadowing. They occur most frequently in older patients or in ‘old’ degenerating benign nodules. However, macrocalcifications, especially if associated with microcalcifications, within a hypoechoic nodule, may be worrisome for malignancy.

Peripheral rim calcifications (‘eggshell’) may be complete or incomplete. Peripheral eggshell calcifications surround the thyroid lesion and are thought to indicate a benign nodule. However, this has also been reported in malignant nodules, especially in cases of incomplete calcification. In fact, the interruption of the rim calcification may indicate probable invasion by the cancer. Therefore, outage in peripheral rim calcification should always be considered a worrisome finding.

Margins

The margins of a thyroid nodule should be described on the basis of their definition and their regularity . It follows that thyroid nodule edges may appear: well defined (when there is a clear demarcation with normal thyroid tissue) or ill defined (lack of clear demarcation with normal thyroid parenchyma) ,regular (without irregularities and imperfections) or irregular (with edges and irregularities), the latter further divided into spiculated (presence of one or more spiculations on its surface) and microlobulated (presence of one or more smooth lobules on its surface).

Ill-defined and irregular, both spiculated and microlobulated, margins are usually reported to be suggestive of malignancy. In fact, malignant nodules may present ill-defined margins due to the infiltration of the surrounding thyroidal parenchyma. Therefore, irregular margins are findings highly suggestive of malignancy . Unfortunately, this finding is also reported in benign conditions such as thyroiditis or in some benign thyroid nodules .

The halo sign is another US pattern that should be described if present. The halo sign appears as a hypoanechoic ring that may completely or incompletely surround a nodule. It is comprised of a pseudocapsule formed by fibrous connective tissue, compressed thyroid tissue and chronic inflammatory change. It can be a regular thin halo or an irregular thick halo. The thin regular halo, which demonstrates the nodule's peripheral vascularity on color Doppler or power Doppler , is a finding usually suggestive of benign lesion , but more than a half of benign nodules lack a halo.

On the other hand, even some papillary carcinomas may have a halo. The thick irregular halo , instead, is usually avascular, and may signify the fibrous capsule surrounding a neoplastic growth.

Size

Thyroid nodules should be measured in all their three diameters. When measuring the nodule size, it is advisable to locate the calipers at the outer margin of the halo of the nodule . The risk of malignancy does **not** change with the size of the nodule that should be precisely documented only for the purpose of follow-up and not for distinguishing a malignant lesion from a benign nodule.

ACR recommends the definition of nodule growth as a 20% increase in the nodule diameter (with a minimum increase in two dimensions of at least 2 mm) or a 50% increase in the nodule volume, according to the American Thyroid Association guidelines .

Cystic nodules usually show slower growth than solid nodules . Moreover, although malignancy is believed to grow more frequently than benignancy, it should be remembered that the majority of benign thyroid nodules also grow with time. Therefore, a growing nodule does not necessarily indicate a tumor. On the contrary, differentiated thyroid cancers may remain unchanged in size for several years.

A very rapid growth of a thyroid nodule should raise the suspicion of anaplastic thyroid carcinoma, thyroid lymphoma, or medullary thyroid carcinoma.

However, nodules that do not grow substantially over the course of 5 years (based on comparison between initial and 5-year sonograms) may be considered benign.

Nodules that exhibit an interval increase in ACR TI-RADS level but remain below the size threshold for FNA should be imaged with follow-up US in 1 year.

American College of Radiology
Thyroid Imaging Reporting and Data System

The ACR TI-RADS chart provides descriptors for each of the five suspicion levels: benign (TR1), not suspicious (TR2), mildly suspicious (TR3), moderately suspicious (TR4), and highly suspicious (TR5).

The TR1 and TR2 nodules were predicted to have a risk of malignancy lower than 2%, and FNA was not recommended for these nodules. The TR3, TR4, and TR5 nodules were predicted to have a risk of malignancy of less than 5%, 5.1–20%, and greater than 20%, respectively, with FNA recommended for those nodules with threshold sizes of 2.5, 1.5, and 1.0 cm, respectively.

Feature (Choice)	Description and Points	TI-RADS Category (Sum of Points) Recommendation
Composition (choose 1)	Cystic or almost completely cystic 0 points Spongiform 0 points Mixed cystic and solid 1 point Solid or almost completely solid 2 points	TR1 (0 points) No FNA No follow-up
Echogenicity (choose 1)	Anechoic 0 points Hyperechoic or isoechoic 1 point Hypoechoic 2 points Very hypoechoic 3 points	TR2 (2 points) No FNA No follow-up
Margin (choose 1)	Smooth or ill-defined 0 points Lobulated or irregular 2 points Extrathyroidal extension 3 points	TR3 (3 points) FNA for nodule ≥ 2.5 cm Follow-up for nodule ≥ 1.5 cm
Echogenic foci (choose all that apply)	None or large comet-tail artifacts 0 points Macrocalcifications 1 point Peripheral (rim) calcifications 2 points Punctate echogenic foci 3 points	TR4 (4—6 points) FNA for nodule ≥ 1.5 cm Follow-up for nodule ≥ 1.0 cm
Shape (choose 1)	Wider than tall 0 points Taller than wide 3 points	TR5 (≥ 7 points) FNA for nodule ≥ 1.0 cm Follow-up for nodule ≥ 0.5 cm

Nodule number: 1

Location: Left upper

Composition: Solid

Echogenicity: Isoechoic

Shape: Wider-than-tall

Margin: Smooth

Echogenic Foci: Peripheral calcifications; macrocalcifications

Size: 1.2 x 1.1 x 0.9 cm

Total Points: 6

ACR TI-RADS category: TR4

Reports of thyroid sonograms should include the following elements:

1. Tridimensional measurements of the right and left lobes and the anteroposterior dimension of the isthmus.

2. An overall description of the thyroid parenchyma.

3. Formal description of up to the four most suspicious nodules.

4. Recommendations for management.

THYROID ULTRASOUND WORKSHEET

Patient risk factors (circle all that applies)

Personal history of thyroid malignancy: Yes, No
Family history of thyroid malignancy: Yes, No
Personal history of radiation: Yes, No
Personal history of endocrine syndrome: Yes, No

Indication for US (circle all that applies)

Goiter
Palpable abnormality
Incidental on CT MRI US PET (circle modality)
Hypothyroid
Hyperthyroid
Prior ultrasound follow-up
Other: _____

Prior thyroid ultrasound: Yes (date/interval _____) No

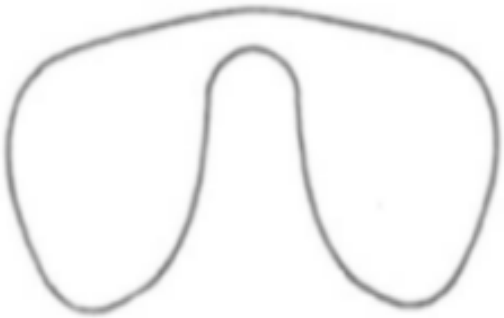
Prior biopsy: Yes (date/interval _____) No

ULTRASOUND FINDINGS

Technologist: _____

Size right lobe: ___ cm craniocaudal X ___ cm transverse X ___ cm anterior-posterior
Size left lobe: ___ cm craniocaudal X ___cm transverse X ___cm anterior-posterior
Size isthmus: ___ cm anterior-posterior
Overall texture (circle): Homogenous, Heterogenous
Estimated total number of nodules ≥1cm: ___ or (circle) 6-10 >10

Size:



№	IMAGES	SIZE (cm)	COMPOSITION	ECHOGENICITY	TALLER-THAN-WIDE	MARGINS	ECHOGENIC FOCI	TOTAL POINTS	TI-RADS LEVEL
		X X							
		X X							
		X X							
		X X							
		X X							

TWO largest nodules & any with IMPORTANT FEATURES	C Cystic 0 Sp Spongiform 0 M Mixed cystic and nodule 1 S Solid 2 **If cystic or spongiform, do not add further points for other categories*	A Anechoic 0 ↑ Hyperechoic 1 = Isoechoic 1 ↓ Hypoechoic 2 ↓↓ Very hypoechoic 3	No 0 Yes 3	S Smooth 0 ID Ill-defined 0 L Lobulated 2 I Irregular 2 E Extra-thyroidal ext 3	N None 0 CT Comet-Tail 0 M Macrocaks 1 PC Periph calc 2 P Punctate 3	0 Pts TR1 Benign 2 Pts TR2 Not Suspicious 3 Pts TR3 Mildly Suspicious 4-6 Pts TR4 Mod Suspicious 7+ TR5 Highly Suspicious			

European Thyroid Imaging Reporting and Data System: EU-TIRADS

EU-TIRADS 1 category refers to a US examination where no thyroid nodule is found.

Benign Category (EU-TIRADS 2)

Risk of malignancy: close to 0%.

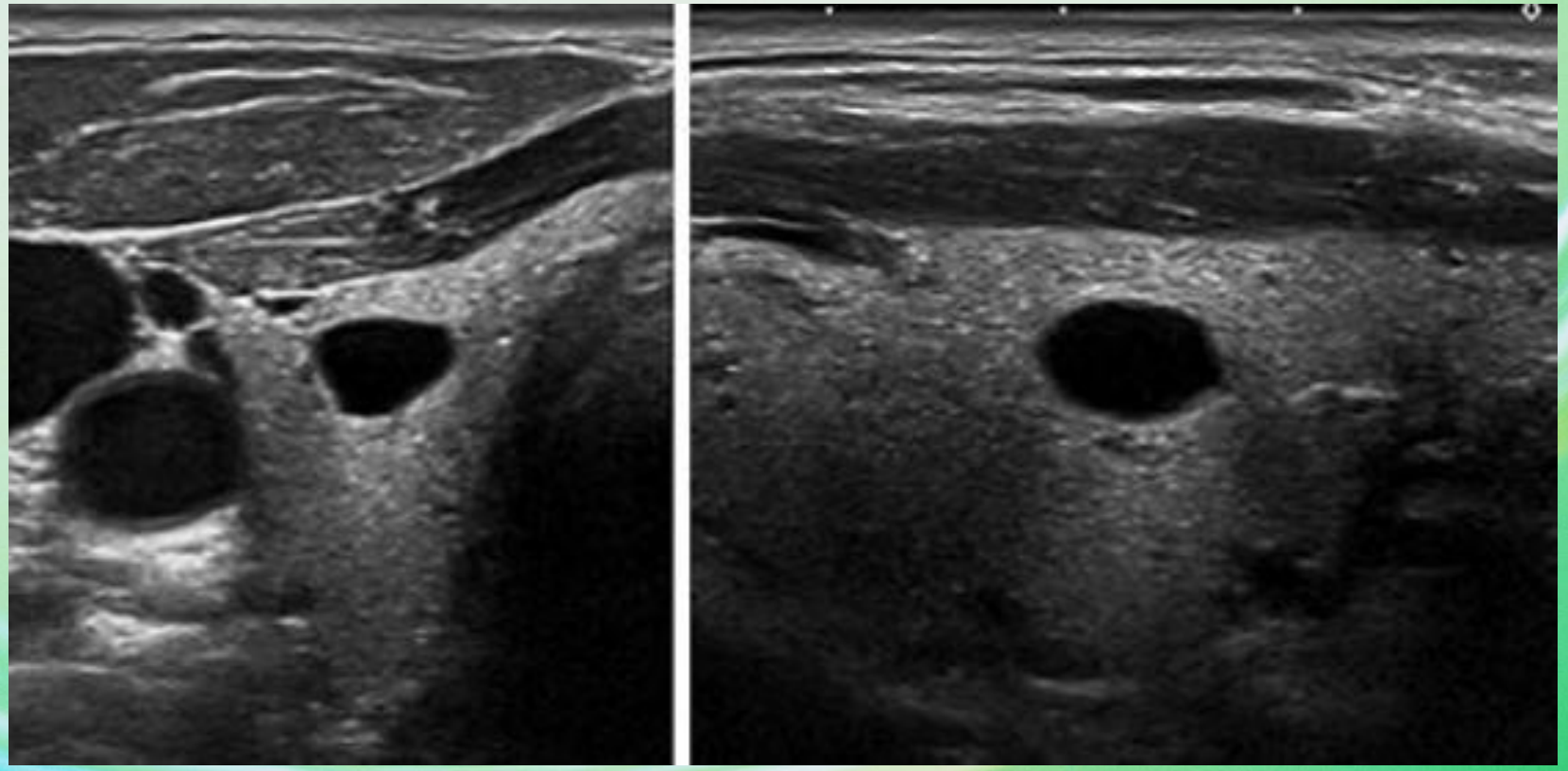
This category includes two patterns: pure/anechoic cysts and entirely spongiform nodules.

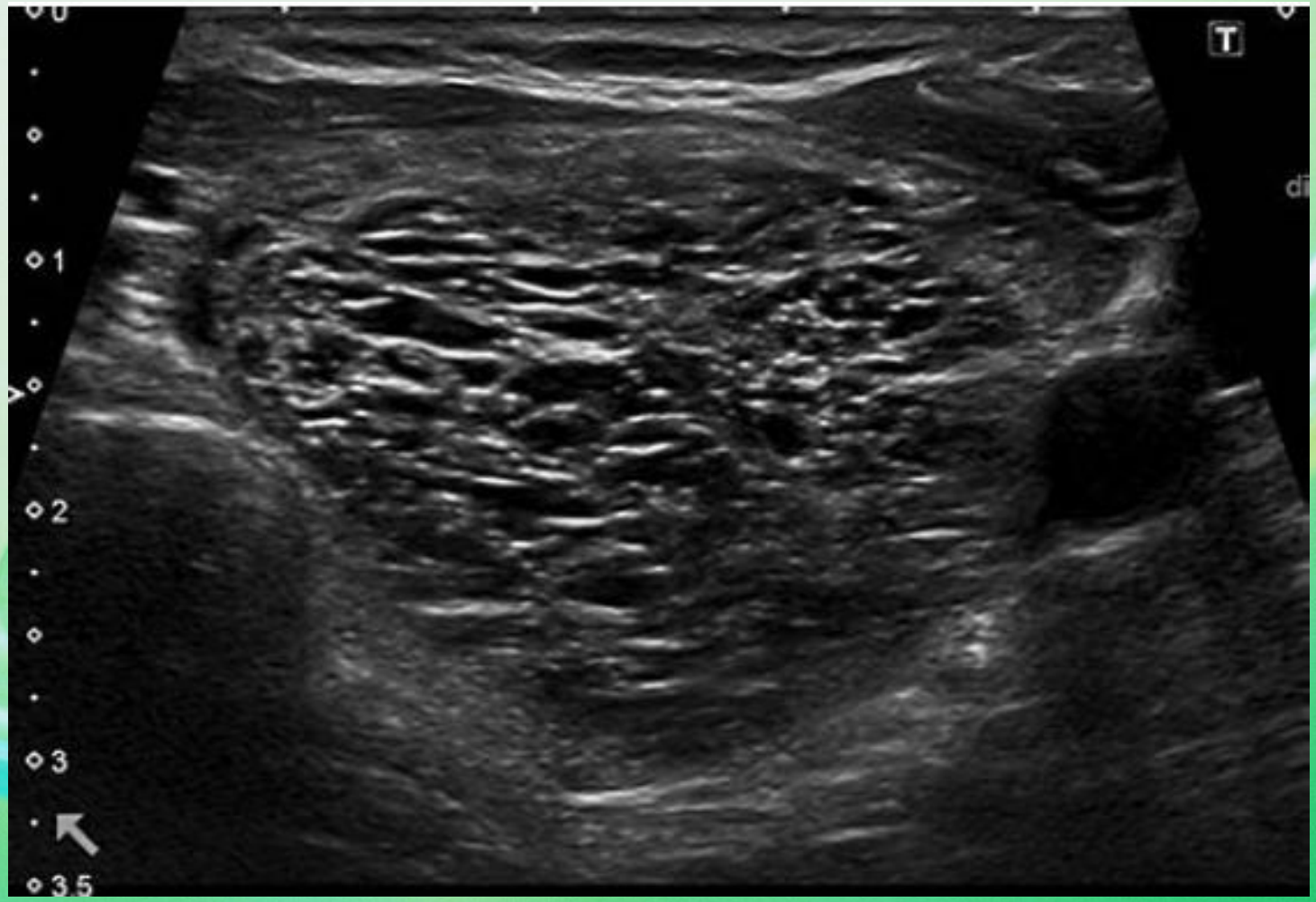
In this category, thyroid US should suffice to assert benignity without the need for FNA.

Purely Cystic Nodules. Absence of wall thickening or a solid component; disregard their size. This category includes cysts which are split into separate compartments by a few traversing septa. The presence of echogenic material inside the cyst is frequently encountered and can correspond either to a fibrin clot or a true solid component, which may be differentiated by the application of Doppler US. If doubt persists regarding the existence of a solid component, the nodule should be included in the low-risk category.

Spongiform Nodules. Composed of tiny cystic spaces involving the entire nodule; disregard their size; separated by numerous isoechoic septa. If the cystic spaces do not involve the entire nodule, the nodule should be considered as low risk.

Pure cysts and entirely spongiform nodules should be considered as benign. FNA is not indicated (unless for therapeutic purposes, in case of compressive symptoms).




0
1
2
3
3.5
T

Low-Risk Category (EU-TIRADS 3)

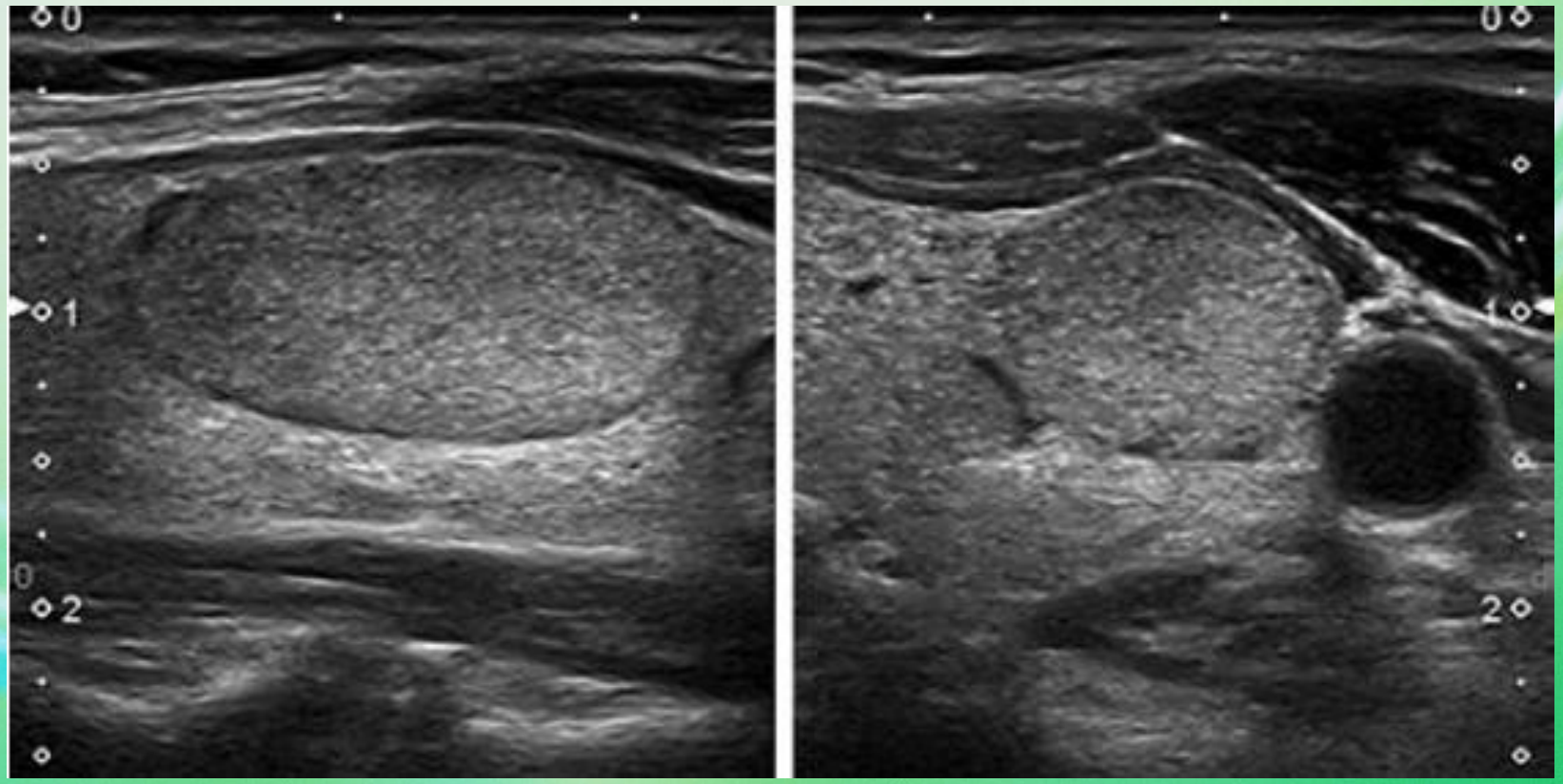
Risk of malignancy: 2–4% .

Oval shape, smooth margins, isoechoic or hyperechoic, without any feature of high risk.

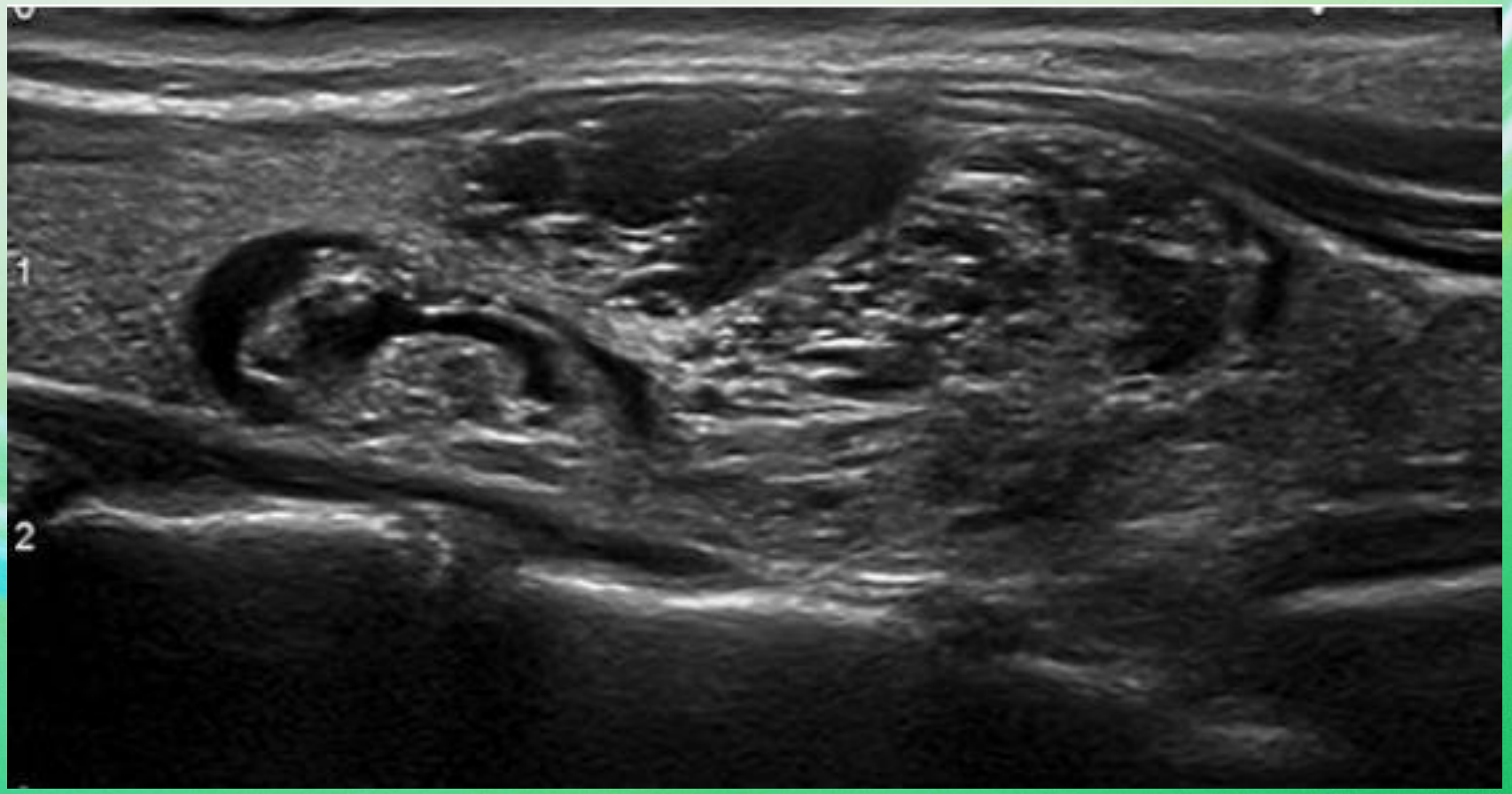
Nodules with these characteristics have a low risk of malignancy, and FNA should usually be considered only for nodules >20 mm. Grouped/coalescing iso echoic nodules should be included in this category, and FNA should be considered if 1 or more of the nodules is >20 mm. It should be pointed out, however, that an entirely solid isoechoic nodule corresponds in <4% of cases to a follicular cancer or a follicular variant of PTC. In contrast, even minimal cystic changes are in favor of benignity.

Oval-shaped, isoechoic, or hyperechoic nodules with smooth margins and no high-risk features should be considered at low risk of malignancy. FNA should usually be performed only for nodules >20 mm.

EU-TIRADS 3: low-risk isoechoic nodule with an oval shape and smooth margins without any high-risk features. Longitudinal (left) and transverse (right) planes



EU-TIRADS 3: grouped low-risk isoechoic nodules with an oval shape and smooth margins without any high-risk features. Longitudinal plane.



Intermediate-Risk Category (EU-TIRADS 4)

Risk of malignancy: 6–17% .

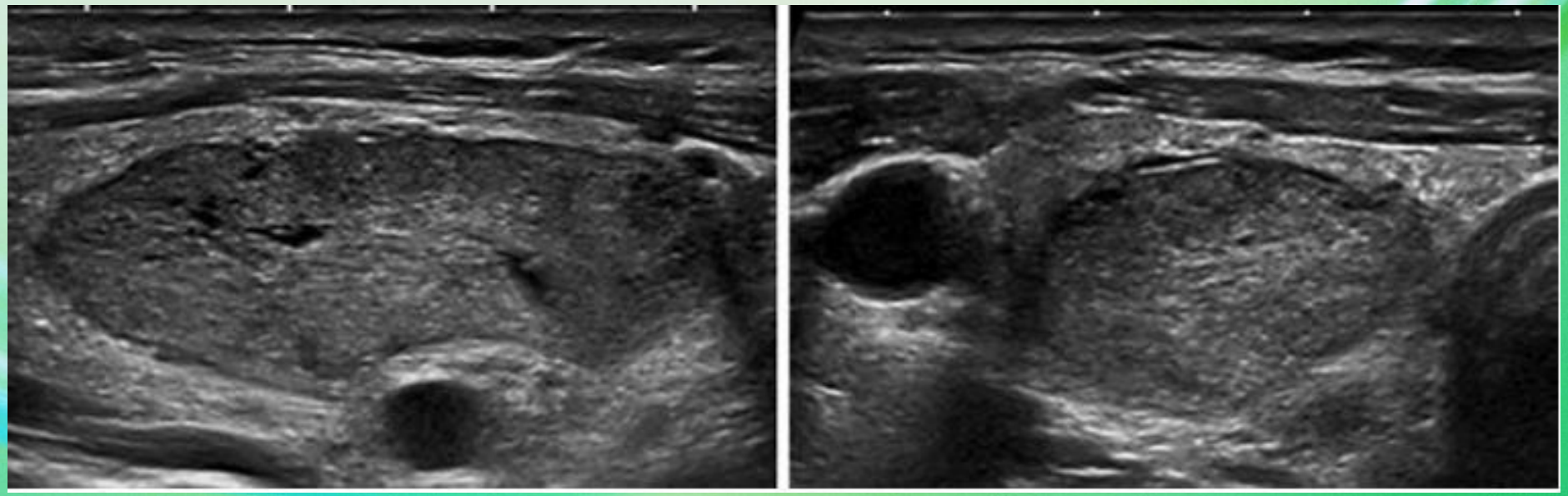
Pattern: Oval shape, smooth margins, mildly hypoechoic, without any feature of high risk.

The difference between the low-risk and the intermediate-risk category lies in the echogenicity of the solid part of the nodule. In case of heterogeneous echogenicity of the solid component, the presence of any hypoechoic tissue classifies the nodule as intermediate risk.

Other features may modulate the risk of malignancy in this category. The presence of a thin halo, a partially cystic composition, comet-tail artifacts, peripheral vascularity, and low stiffness lower the malignancy risk.

Oval-shaped, mildly hypoechoic nodules with smooth margins and no high-risk features should be considered at intermediate risk of malignancy. FNA should usually be performed for nodules >15 mm.

EU-TIRADS 4: intermediate-risk, mildly hypoechoic nodule with an oval shape and smooth margins without any high-risk features. Longitudinal (left) and transverse (right) planes.



High-Risk Category (EU-TIRADS 5)

Risk of malignancy: 26–87%

Pattern. Nodules with at least 1 of the following high risk features: non-oval shape, irregular margins, microcalcifications, and marked hypoechogenicity .

All these characteristics show high rates of specificity (83–84%), but also low rates of sensitivity (26–59%).

Marked hypoechogenicity has the lowest sensitivity of the four features, and is only specific if the nodule is solid and not the scar of a healed cyst. The value of these features is also dependent on composition. In partially cystic nodules, microcalcifications are the best predictor of malignancy, whereas other features seem less significant. The number of spiculations, lobulations, or punctate echogenic foci has to be taken into account to gain specificity, which increases with the number of these anomalies.

All such nodules >10 mm should undergo FNA. In case of a first benign cytological result, FNA should be repeated within 3 months to reduce the rate of false-negative samples.

In case of subcentimeter nodules with high-risk US features, active surveillance is recommended, provided that there are no abnormal lymph nodes and the patient is willing to accept regular US scanning. In case of proven growth or detection of a suspicious lymph node during surveillance, FNA should be performed.

US Management in **Multinodular Disease**

EU-TIRADS scoring is useful in multinodular thyroid disease to select nodules for FNA. The following process can be applied:

1. Begin looking for high-risk nodules and describe them, disregarding their size; perform FNA if the nodule is >10 mm
2. Look for intermediate-risk nodules; describe those >5 mm and perform FNA if they are >15 mm
3. Look for low-risk nodules; describe those >10 mm and perform FNA if they are >20 mm
4. If there are numerous nodules, at least the 3 most important ones (according to the risk and size criteria) should be described in detail .

US assessment of the lymph nodes is advised for all thyroid nodules but is mandatory for intermediate and high-risk ones. In case of a suspicious lymph node of thyroid origin, FNA of the lymph node and FNA of the most suspicious thyroid nodule(s) should be performed.

Capsular bulging, disruption, or abutment by the thyroid nodule are indicative of extrathyroidal extension and should be described in the report.

the presence of a >2-mm normal thyroid parenchyma between the nodule and a continuous capsule reduces the risk of microscopic extra thyroidal extension to <6% with little or no chance of macroscopic invasion.

Macrocalcifications can be defined as echogenic foci >1 mm in size with posterior shadowing. Three different patterns can be described:

1. Central intranodular macrocalcifications alone: not consistently associated with malignancy

2. Isolated macrocalcification, occupying an entirely calcified nodule: low risk

3. Rim (peripheral or curvilinear) or eggshell calcifications at the nodule margin: may increase the malignancy risk if disrupted

Macrocalcifications alone are not specific for malignancy.

Their presence should be correlated with other

US features supporting FNA. True micro calcifications should be differentiated from other echogenic spots, and such nodules must undergo FNA. Echogenic spots with comet-tail artifacts are suggestive of benignity.

Vascularity

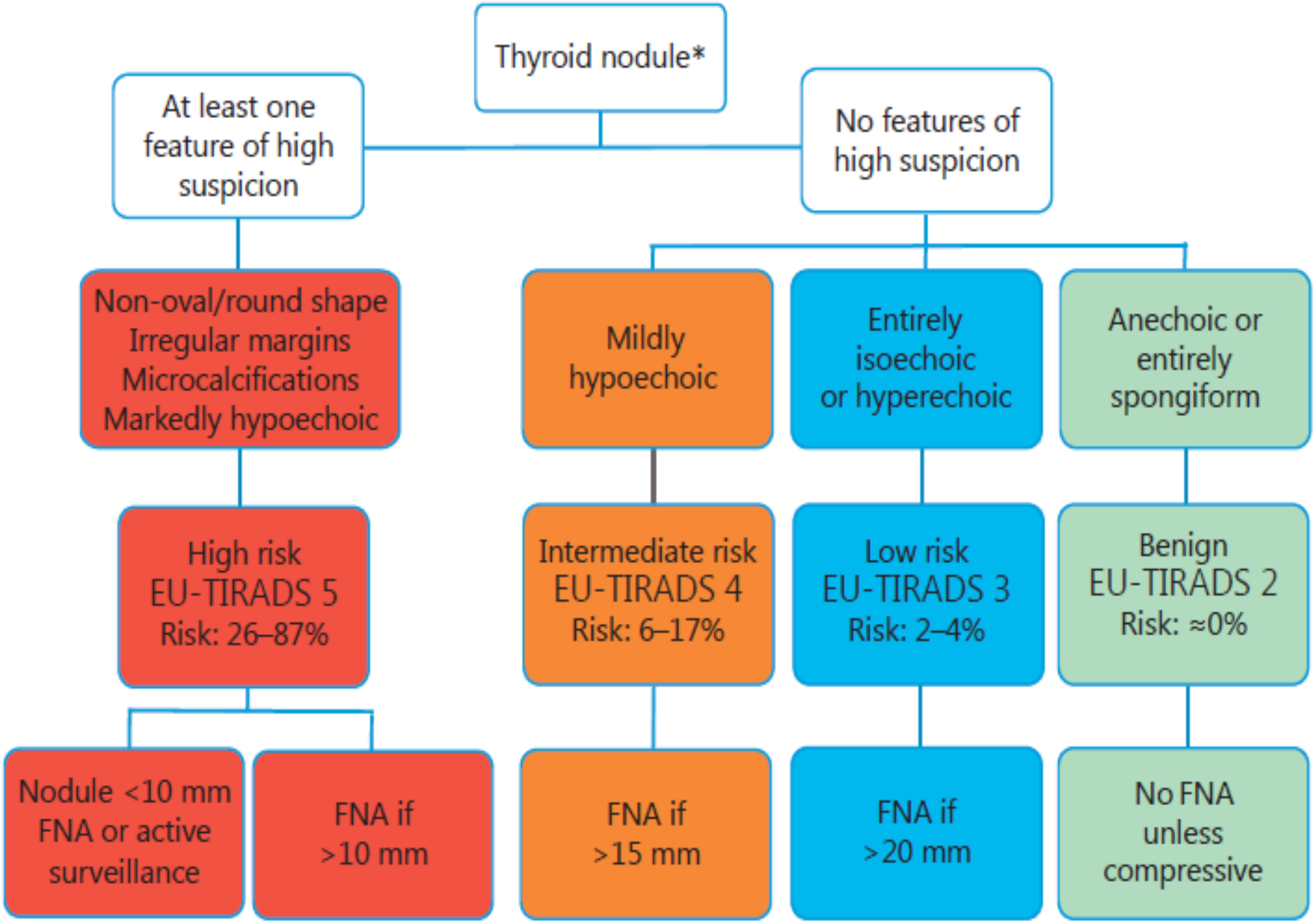
–– Type I: absence of intranodular or perinodular flow

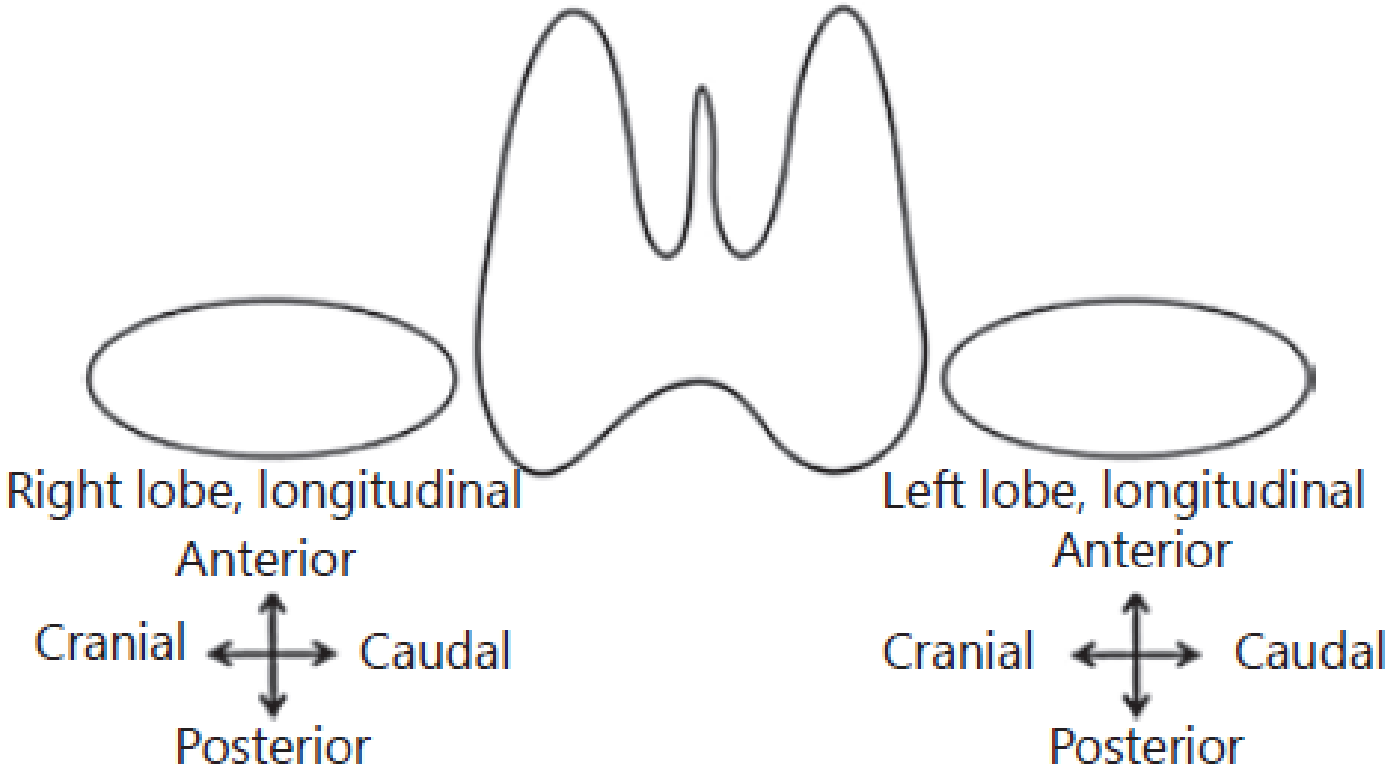
–– Type II: presence of perinodular and/or slight intranodular flow

–– Type III: presence of marked intranodular and slight perinodular flow

Malignant nodules are more prone to have type III vascularity, while benign nodules tend to show type I and II signal patterns. However, the intranodular signal increases also with an increasing size of benign nodules. As for type III vascularity, the sensitivity, specificity, and positive predictive value for malignancy are low, but they may be increased by additional suspicious sonographic features. The Doppler criteria remain controversial, mainly because is highly dependent on the US equipment and settings. Therefore, the ETA does not recommend the inclusion of Doppler assessment in the TIRADS score. However, it can be used to differentiate solid tissue from thick colloid, or to enhance the detection of the limits of a nodule in an isoechoic parenchyma.

The routine use of Doppler US is not recommended for US malignancy risk stratification.


Thyroid nodule*
At least one feature of high suspicion
No features of high suspicion
Non-oval/round shape
Irregular margins
Microcalcifications
Markedly hypoechoic
Mildly hypoechoic
Entirely isoechoic or hyperechoic
Anechoic or entirely spongiform
High risk
EU-TIRADS 5
Risk: 26–87%
Intermediate risk
EU-TIRADS 4
Risk: 6–17%
Low risk
EU-TIRADS 3
Risk: 2–4%
Benign
EU-TIRADS 2
Risk: ≈0%
Nodule <10 mm
FNA or active surveillance
FNA if >10 mm
FNA if >15 mm
FNA if >20 mm
No FNA unless compressive


Right lobe, longitudinal
Anterior
Cranial
Caudal
Posterior
Left lobe, longitudinal
Anterior
Cranial
Caudal
Posterior

Standardized reporting

Technique US equipment, type of probe

Patient risk factors(Family history of thyroid cancer and History of neck irradiation during childhood, or known operative history with regard to the neck or thyroid)

Former FNA results

Thyroid volume

Echogenicity and vascularity of the gland

Nodules (above 5 mm unless highly suspect)

Location (side, superior, medial, inferior)

Size (3 diameters +/– volume)

Shape, margins, echogenicity, composition, echogenic foci

Numbered and mapped out on the thyroid map

Retrosternal extension

Trachea deviation

Study of lymph nodes (levels II, III, IV, V, VI)

Conclusion: Normal examination or type of pathology

Comparison to previous documents

Final assessment category of the nodules (EU-TIRADS score)

Management recommendations

Korean Thyroid Imaging Reporting and Data System

K-TIRADS 1: no nodule

K-TIRADS 2: benign

K-TIRADS 3 (low): partially cystic / isohyperechoic with no suspicious features

K-TIRADS 4 (intermediate): as for K-TIRADS 3 but with any suspicious features or as for K-TIRADS 5 without suspicious features

K-TIRADS 5 (high): solid hypoechoic nodule with any suspicious features

Suspicious features include microcalcifications, taller-than-wide orientation, spiculated/microlobulated margins

Sensitivity for malignancy for each stage is:

K-TIRADS 2: 0%

K-TIRADS 3: 19.2%

K-TIRADS 4: 29.5%

K-TIRADS 5: 51.3%

K-TIRADS, unlike the ACR-TI-RADS and EU-TIRADS systems has no recommendations for follow-up without FNA.

K-TIRADS 2: if a spongiform nodule is ≥2 cm FNA is recommended.

K-TIRADS 3: ≥1.5 cm

K-TIRADS 4: ≥1 cm

K-TIRADS 5: ≥1 cm (in select cases >0.5 cm)

Biopsy should be performed regardless the nodule size if extrathyroid extension or nodal metastasis is suspected

Although macrocalcification and peripheral (rim) calcification were not used for risk categorization in Korean TIRADS or European TIRADS, they were used as points for estimating malignancy risk, and the points were additive for each type of echogenic foci in ACR TIRADS which used the point-based system, whereas Korean TIRADS and European TIRADS used a pattern-based system.

Isolated macrocalcification was defined as an entirely calcified nodule without any solid component in which assessment of other US characteristics was impossible owing to dense posterior shadowing and absence of a visible solid component. Isolated macrocalcification was categorized as a nodule of intermediate suspicion in Korean TIRADS and of moderate suspicion (4 points) in ACR TI-RADS; it was unclassifiable in European TIRADS. Although extrathyroidal extension was used for risk stratification in ACR TI-RADS, it was not used in Korean TIRADS or European TIRADS.

Recent comparative studies have consistently shown that the biopsy criteria of the K-TIRADS for nodules ≥ 1 cm had the highest sensitivity (91.7–100%) and lowest specificity (15.4–28.7%) for diagnosing malignant tumors, but the highest rate of unnecessary biopsy of benign nodules (71.3–84.6%). Meanwhile, the biopsy criteria of the ACR-TIRADS had the lowest sensitivity, highest specificity, and lowest rate of unnecessary biopsy of benign nodules.

These results suggest the need for modifying the K-TIRADS to reduce the unnecessary biopsy rate. The differences in diagnostic performance among the RSSs are mainly attributed to differences in the size threshold for biopsy rather than to differences in the structure (pattern-based vs. point-based system) or US criteria for nodule classification. The diagnostic performances of the different RSSs were similar at the same size threshold for biopsy .

Considering the good prognosis and slow-growing nature of most thyroid cancers, the rate of unnecessary FNA in the current Korean TIRADS must be reduced. ACR TIRADS proposes higher size thresholds for biopsy and US monitoring of nodules that do not meet the size thresholds.

ATA guidelines for assessment of thyroid nodules

On a thyroid ultrasound, a nodule is classified into one of five categories:

- benign pattern (0% risk): no biopsy
- very low suspicion pattern (<3% risk): biopsy if ≥2 cm
- low suspicion pattern (5-10% risk): biopsy if ≥1.5 cm
- intermediate suspicion pattern (10-20% risk): biopsy if ≥1 cm
- high suspicion pattern (>70-90% risk): biopsy if ≥1 cm

Benign pattern (0% risk)

completely cystic nodules with well-defined walls

Very low suspicion pattern (<3% risk)

spongiform nodules and nodules with interspersed cystic spaces, without any of the features in more suspicious patterns

Low suspicion pattern (5-10% risk)

isoechoic or hyperechoic nodule

partially cystic nodule with a peripheral solid component

none of the following features:

Microcalcifications ,irregular margins, extrathyroidal extension, taller than wide

Intermediate suspicion pattern (10-20% risk)

hypoechoic solid nodule with smooth margins

none of the following features:

microcalcifications , irregular margins, extrathyroidal extension, taller than wide

High suspicion pattern (>70-90% risk)

solid hypoechoic nodule (or solid hypoechoic component of a partially cystic nodule), with at least one of these features:

microcalcifications ,irregular margins (infiltrative, microlobulated) ,extrathyroidal extension, taller than wide ,rim calcifications with an extrusive soft tissue component, lymphadenopathy

AACE/AME

• Class 1. Low-risk thyroid lesion.

- Mostly cystic (>50%) nodules with reverberating artifacts that are not associated with suspicious US signs

- Isoechoic spongiform nodules , confluent or with regular halo

- The expected risk of malignancy is about 1%.

• Class 2. Intermediate-risk thyroid lesion.

- Slightly hypoechoic nodules and isoechoic nodules with ovoid-to-round shape and smooth or ill-defined margins.

- Intranodular vascularization, elevated stiffness at elastography, macro- or continuous rim calcifications, or hyperechoic spots of uncertain significance may be present.

- The expected risk of malignancy is 5 to 15%.

• Class 3. High-risk thyroid lesion. Nodules with at least 1 of the following suspicious features:

- Marked hypoechogenicity

- Spiculated or microlobulated margins

- Microcalcifications

- Taller-than-wide shape

- Evidence of extrathyroidal growth or pathologic adenopathy

- The expected risk of malignancy is 50 to 90%

FNA indications :

1) ≥ 1 cm if Class 3^

2) > 2 cm if Class 2^

- In the selection of nodules for FNA, consider a balance between the risk of a potentially delayed diagnosis and that of superfluous diagnostic procedures or surgery
- In light of the low clinical risk, nodules with a major diameter <5 mm should be monitored
- In nodules with a major diameter 5-10 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, US-guided 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

¡ Coexistent suspicious clinical findings (e.g., dysphonia)

- FNA is recommended for the following:

¡ High US risk thyroid lesions ≥10 mm

¡ Intermediate US risk thyroid lesions >20 mm

¡ Low US risk thyroid lesions only when >20 mm and increasing in size or associated with a risk history .

- FNA is not recommended for nodules that are functional on scintigraphy

ACR-TIRADS had higher interobserver agreement, a trend to have highest negative predictive value for diagnosis of malignant thyroid nodules. The ACR TIRADS classification system is less invasive and can identify suspicious nodules more accurately than that of ATA and AACE (American Association of Clinical Endocrinologists) / ACE (American College of Endocrinology) / AME (Associazione Medici Endocrinologi).

The ACR TI-RADS provides comprehensive guidelines for determining when sonographic follow-up is necessary for nodules that do not meet the criteria for biopsy . The purpose of the follow-up examinations is to detect malignant nodules that do not initially meet criteria for biopsy. The KSThR TIRADS does not provide any guidelines for follow-up, and the ATA guidelines for nodules that do not meet the criteria for biopsy are not comprehensive.

Two major differences between the ACR TI-RADS and the other systems is the elimination of a recommendation for FNA for nodules with certain features that are highly likely to be benign and the higher size thresholds for FNA of nodules with features of intermediate suspicion. For instance, the ACR TI-RADS does not recommend FNA of mixed solid and cystic nodules that are hyperechoic or isoechoic and have no malignant features, whereas the ATA and KSThR systems recommend FNA at size thresholds of 2 cm or larger and 1.5 cm or larger, respectively.

Solid nodules that are hyperechoic or isoechoic and have no malignant features have an FNA size threshold of 2.5 cm or larger in the ACR TI-RADS, as compared with 1.5 cm or larger in the ATA and KSThR systems

The ACR TI-RADS does not recommend FNA of spongiform nodules of any size.

The ATA guidelines recommend that FNA be performed on spongiform nodules 2 cm or larger in the evaluation and management algorithm; the guidelines also recommend that FNA be considered as the first option for spongiform nodules with a size threshold of 2 cm or larger .The KSThR TIRADS recommends in its risk stratification chart that FNA be performed on spongiform nodules at a threshold of 2 cm or larger .

These differences produced fewer biopsies when the ACR TI-RADS was used.

The ACR TI-RADS criteria that allow reduction in the percentage of benign nodules that are biopsied would also be expected to result in a lower percentage of malignant nodules that are biopsied. This is unavoidable because there are some malignancies that have benign sonographic features.

With the knowledge that some cancers will be missed, the goal of all classification systems is to minimize the number of clinically significant cancers that are missed.

Another important difference between the ACR TI-RADS and the other classification systems is the detailed and definitive recommendation for 5-year sonographic follow-up. These follow- up recommendations are advantageous and should result in detection of some of the cancers that otherwise would have been overlooked.

TR5 (≥7 points) -FNA if ≥ 1cm, follow-up if 0.5 -0.9 cm every year for 5 years

TR4 (4-6 points) -FNA if ≥ 1.5cm, follow-up if 1 -1.4 cm in 1, 2, 3 and 5 years

TR3 (3 points)-FNA if ≥ 2.5cm, follow-up if 1.5 -2.4 cm in 1, 3 and 5 years

TR2 (2 points) & TR1 (0 points) -No FNA or follow-up

The ATA guidelines provide follow-up recommendations for some categories of nodules that do not meet criteria for FNA.

Repeat ultrasound in 6–12 months is recommended for nodules with high suspicion of malignancy. Consideration for repeat ultrasound in 12–24 months is recommended for nodules with low to intermediate suspicion for malignancy. For nodules with very low suspicion, no recommendation for or against follow-up of nodules larger than 1 cm exists, and the recommendation for nodules 1 cm or smaller is no follow-up.

The recommendations for nodules with intermediate or low suspicion of malignancy are not definitive. Because of these limitations, a definitive recommendation for no further evaluation (no FNA or followup) would be made for only 1.5% of nodules using the ATA guidelines, compared with 32.3% of nodules using the ACR TI-RADS.

Follow-up recommendations are not included in the current KSThR TIRADS.

The structures of the thyroid reporting and data systems are inherently different in that Korean TIRADS and EuTIRADS are pattern based and ACR TI-RADS is point based. The advantage of a pattern-based system is that it can be intuitive and feasible for clinical application if the system is simplified.

However, a simplified system has the possible dis-advantage of less accurate estimation of the malignancy risk of each individual nodule.

Although the point-based system may be less intuitive for clinical application than the simplified pattern-based system is, it could provide a more accurate estimation of individual nodules.

CONCLUSION

??????