University Hospital Birmingham
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NHS

THYROID NODULE ULTRASOUND

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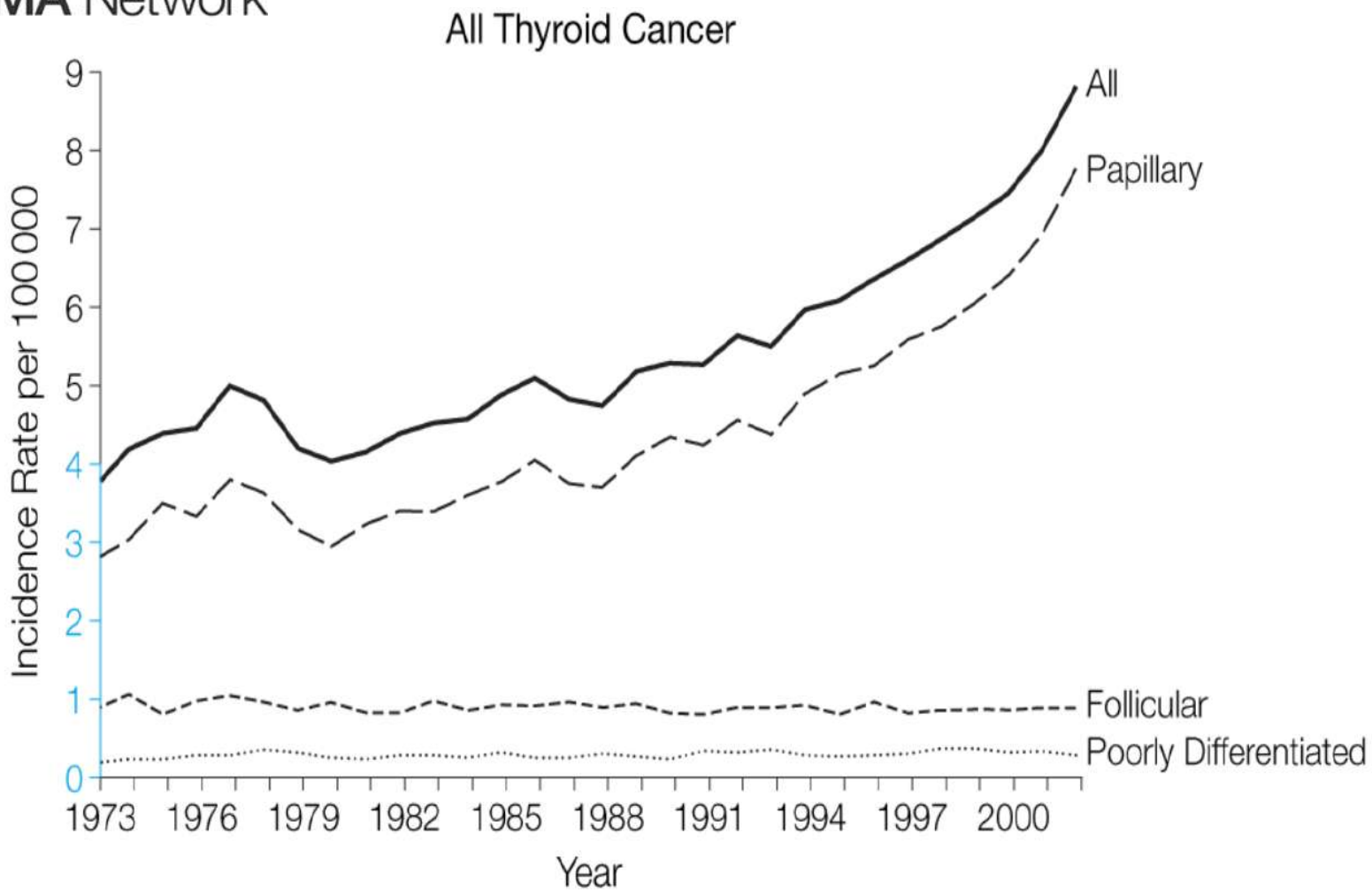
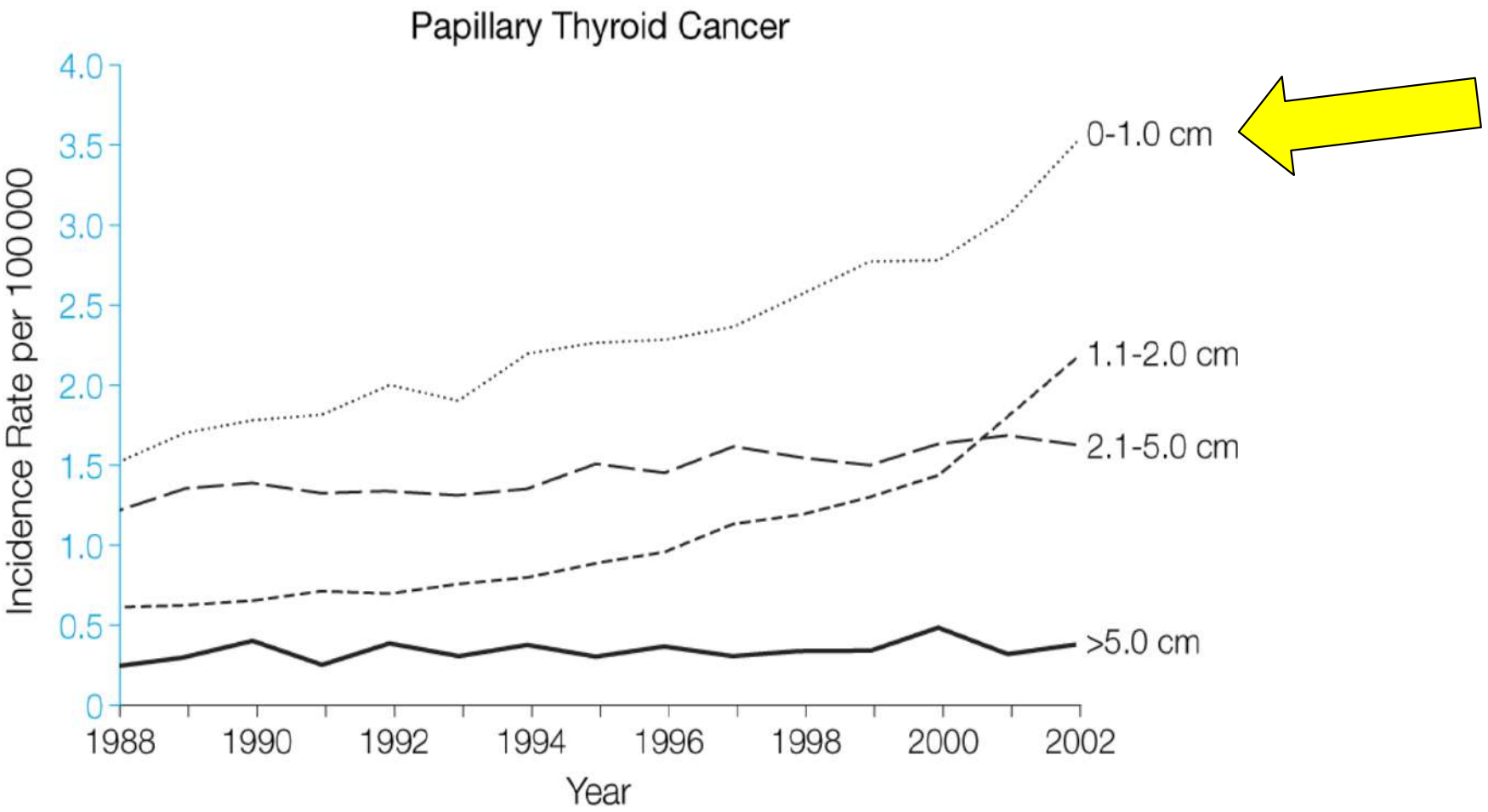
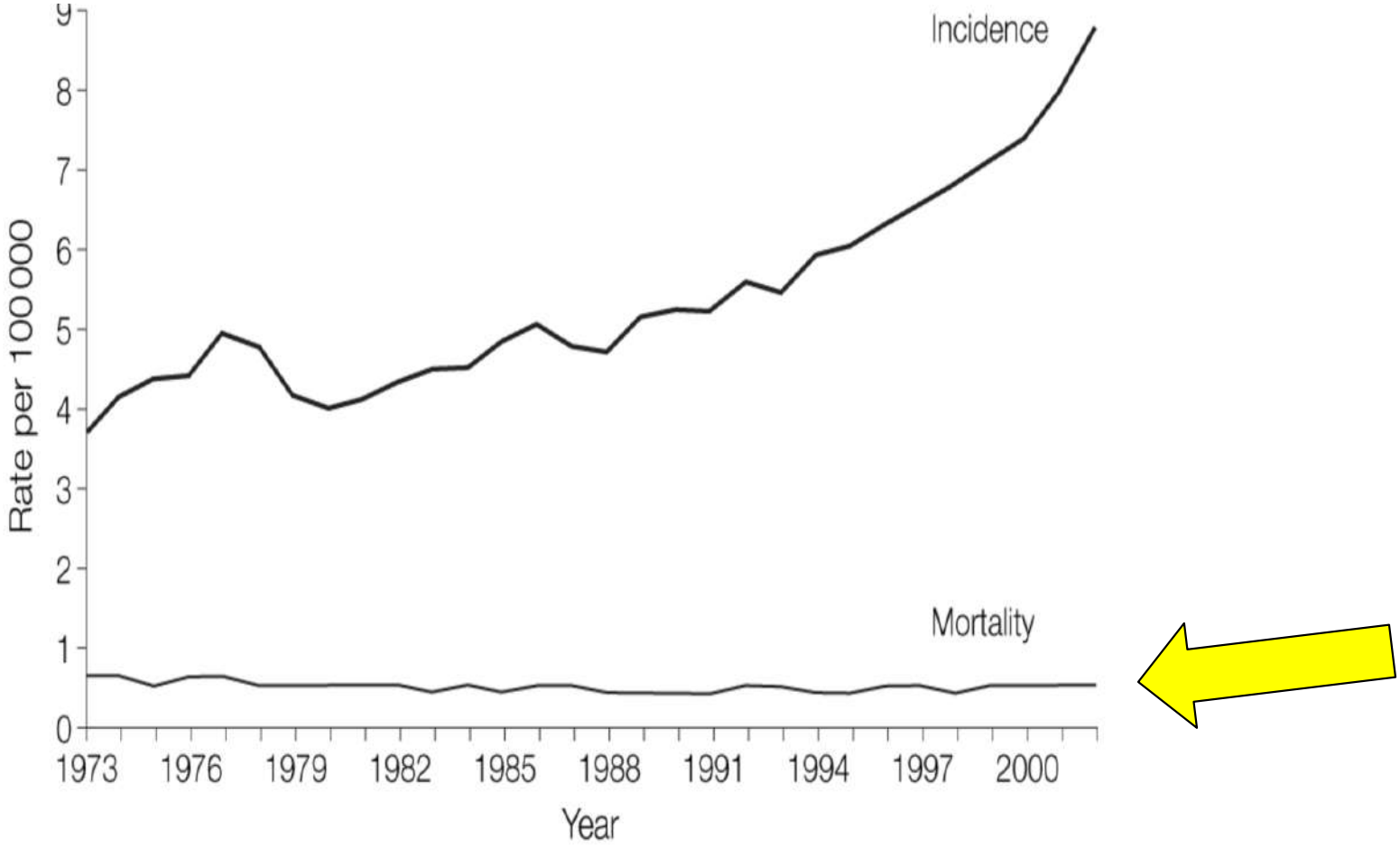
October 2017

Areas to cover…

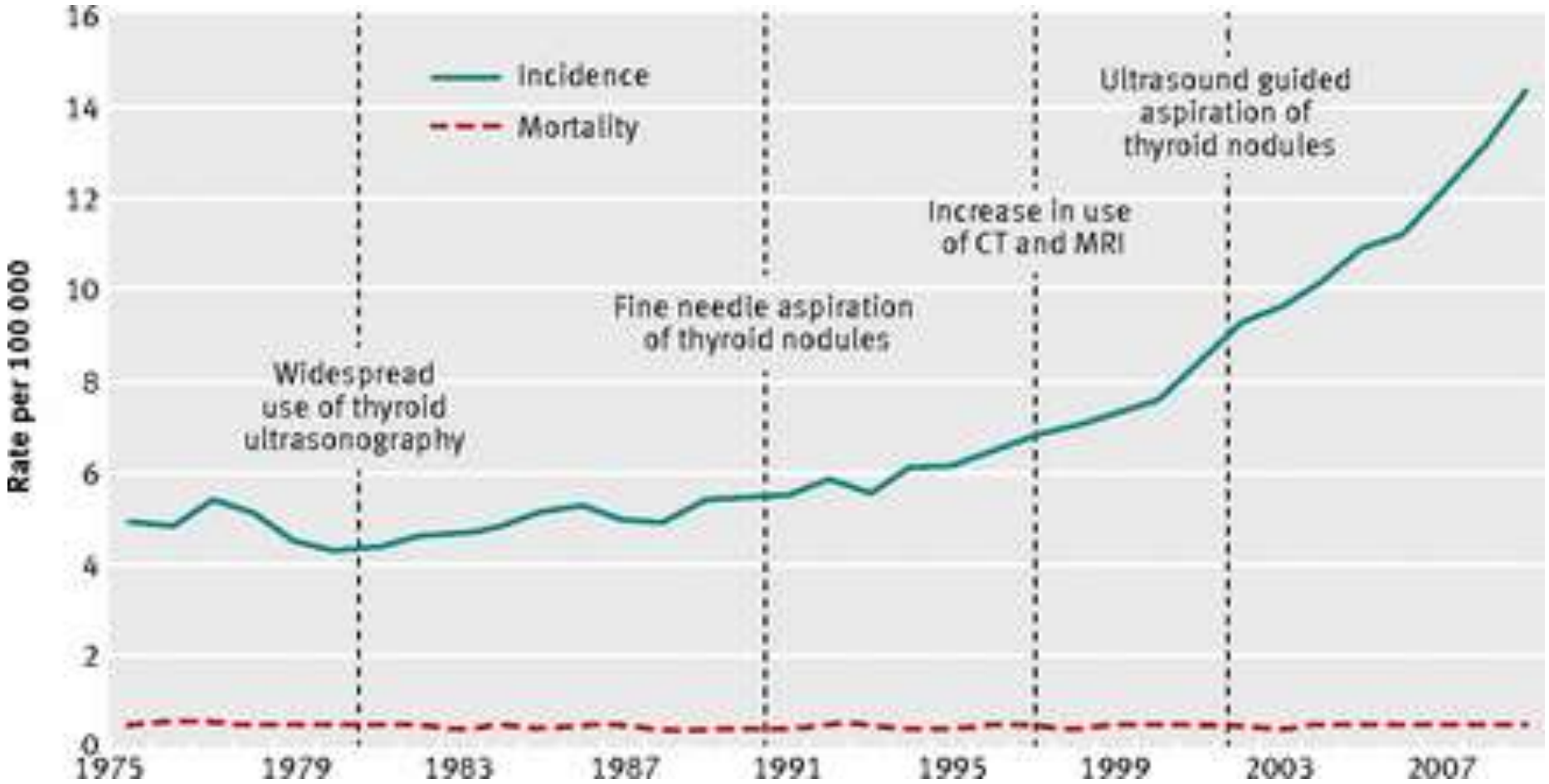
- Ultrasound
  - Imaging as part of thyroid cancer epidemic
  - Ultrasound performance
- BTA Guidelines
  - Scoring systems







The Role of Imaging…



Thyroid cancer: zealous imaging has increased detection and treatment of low risk tumours. Brito et al. BMJ 2013; 347: 18 – 21.

Numbers from North America

37,000 DTC diagnoses 2009

63,000 DTC diagnoses 2014

4.9 / 100,000 1975

INCIDENCE

14.3 / 100,000 2008-9

- *Doubling of thyroid cancer between 2000 – 2012 is purely attributable to clinically occult cancers detected incidentally on imaging or pathology*

Brito et al. The impact of subclinical disease and mechanism of detection on the rise in thyroid cancer incidence: a population based study 1935 – 2012. Thyroid 2015. 25: 999 - 1007

Unintended Consequences

Solutions to the thyroid problem

- Ultrasound based solution
- Reduce unnecessary FNA / biopsy
- In turn, reduce unnecessary diagnostic hemi-thyroidectomy for benign disease
- Reduce sub-clinical tiny papillary cancer detection

US Appearances of Nodules

Benign and Malignant Thyroid Nodules: US Differentiation—Multicenter Retrospective Study[1]

Radiology

Radiology 2008; 247:762–770

US Features of Thyroid Malignancy: Pearls and Pitfalls[1]

RadioGraphics 2007; 27:847–865

Risk of Malignancy in Nonpalpable Thyroid Nodules: Predictive Value of Ultrasound and Color-Doppler Features

Papini *et al.* • Management of Nonpalpable Thyroid Nodules
J Clin Endocrinol Metab, May 2002, 87(5):1941–1946 **1943**

EnM
ENDOCRINOLOGY AND METABOLISM

Review Article

Endocrinol Metab 2013;28:81-85
http://dx.doi.org/10.3803/EnM.2013.28.2.81
pISSN 2093-596X · eISSN 2093-5978

Indications for Fine Needle Aspiration in Thyroid Nodules

Jin Young Kwak

Management of Thyroid Nodules Detected at US: Society of Radiologists in Ultrasound Consensus Conference Statement[1]

Radiology 2005; 237:794–800

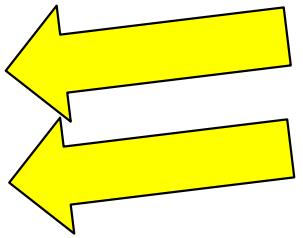
Revised American Thyroid Association Management Guidelines for Patients with Thyroid Nodules and Differentiated Thyroid Cancer

The American Thyroid Association (ATA) Guidelines Taskforce on Thyroid Nodules and Differentiated Thyroid Cancer

THYROID
Volume 19, Number 11, 2009

US Signs Predictive of Cancer

	Sensitivity	Specificity
Micro-calcifications	40%	90%
Absence of halo	66%	
46%		
Irregular margins	64%	84%
Hypo-echoic	83%	
49%		
Intra-nodular flow	70%	65%
MicroCa. & irreg m.	30%	95%
MicroCa. & hypoechoic	28%	95%
Solid & hypoechoic	73%	69%



What do you want from US?

- High sensitivity or specificity
- PPV
- NPV
- Accuracy

- *High Negative Predictive Value*

US Signs Predictive of Cancer

Biopsy of Thyroid Nodules: Comparison of Three Sets of Guidelines

Sung Soo Ahn[1]
Eun-Kyung Kim[1]
Dae Ryong Kang[2]
Sung-Kil Lim[3]
Jin Young Kwak[1]
Min Jung Kim[1]

AJR 2010; 194:31–37

Kim

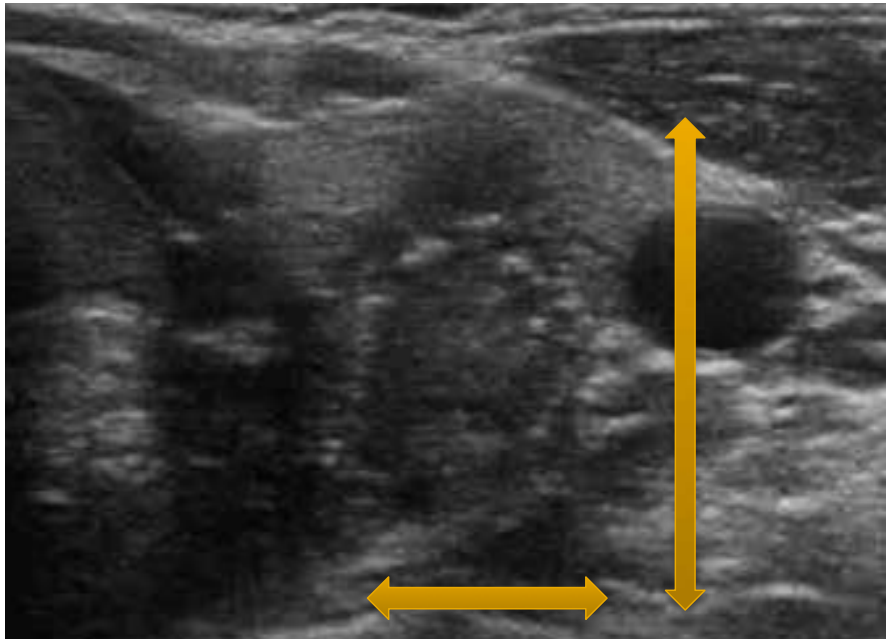
AACE

SRUS

1398 nodules

Kim Criteria

- FNA of any nodule with <u>one</u> of:
  - Markedly hypo-echoic
  - Micro-calcification
  - Irregular margins
  - Taller-than –wide shape



Kim EK, Park CS, Chung WY et al. New sonographic criteria for recommending fine needle aspiration biopsy of nonpalpable solid nodules of the thyroid. *AJR* 2002; 178: 687 – 691.

AACE Criteria

- FNA of any nodule with:
  - Marked hypo-echogenicity + one other:
    - Micro-calcification
    - Irregular margins
    - Taller-than-wide shape

Gharib H, Papini E, Valcavi R et al. American Association of Clinical Endocrinologists and Associazone Medici Endocrinologi medical guidelines for the diagnosis and management of thryoid nodules. *Enodcr Pract* 2006; 12: 63 – 102.

Society of Radiologists in US

- FNA any nodule with:
  - > 10mm with micro-calcification
  - >15mm if solid
  - >15mm if coarse calcification
  - >20mm if solid and cystic

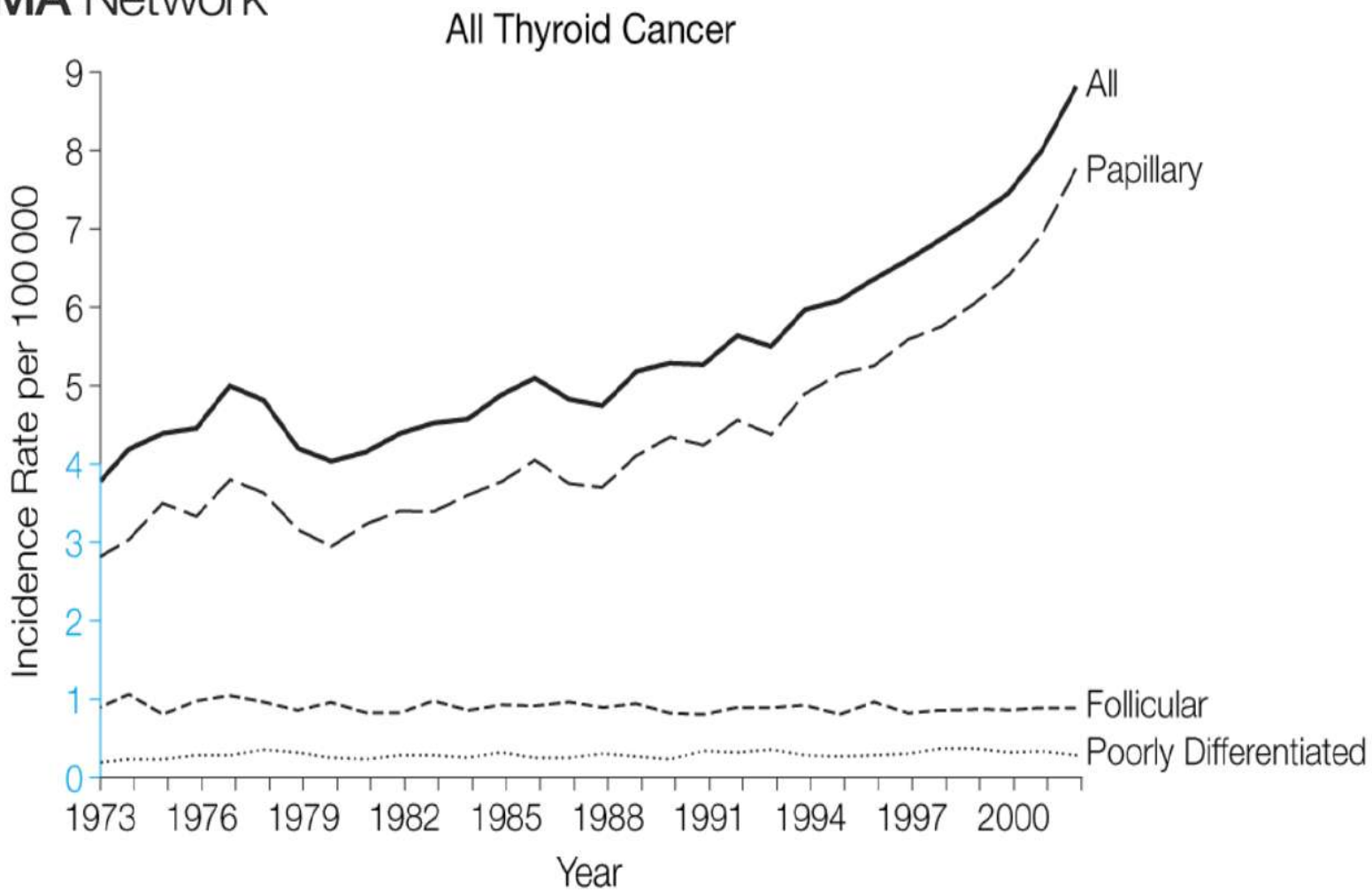
Frates MC, Benson CB, Charboneau JW et al. Management of thyroid nodules detected at US: Society of Radiologists in Ultrasound consensus conference statement. *Radiology* 2005; 237: 794 – 800.

- Kim Criteria
  - Sensitivity 92.7% Specificity 80.9%
  - NPV 97.3%
- AACE Criteria
  - Sensitivity 74% Specificity 94.4%
  - NPV 95%
- SRUS
  - Sensitivity 35% Specificity 54%
  - NPV 80%

B mode performance

- In the absence of one of the following:
  - Marked hypoechogenicity
  - Irregular margins
  - Micro-calcifications
  - Taller-than-wide shape

- *NPV for presence of thyroid cancer is in excess of 97%*



Ultrasound Scoring Systems

Niamh M. Hambly[1,2]
Mithat Gonen[3]
Scott R. Gerst[1]
Duan Li[1]
Xiaoyu Jia[3]
Svetlana Mironov[1]
Debra Sarasohn[1]
Stephen E. Fleming[1]
Lucy E. Hann[1]

Implementation of Evidence-Based Guidelines for Thyroid Nodule Biopsy: A Model for Establishment of Practice Standards

AJR 2011;196: 655 - 660

- Use of scoring systems is robust
  - Training possible
  - Good inter observer variability
  - Allows effective audit / follow

Ultrasound Scoring Systems

- *Ultrasound based reporting system for thyroid nodules improves patient management and cost-effectiveness by reducing unnecessary FNA*

Horvath E et al. An ultrasonogram reporting system for thyroid nodules stratifying cancer risk for clinical management. *J Clin Endocrinol Metab* 2009; 94: 1748 - 1751

Mayo Clinic Thyroid US Chart

Almost Certainly Benign

No FNA


Cysts with bright echo


Cystic nodule


Sponge-like nodule


Cystic with debris


Large cystic nodule with septations


Cystic nodule with debris



Multiple isoechoic similar nodules (multinodular goiter)


Multiple discrete solid hypoechoic nodules with coarse parenchymal septations (Hashimoto's Thyroiditis)

Indeterminate



Solid with cystic component


Cystic with mural nodule



Solid, homogenous with thin halo


Solid, homogenous

Most are benign, uncommonly follicular or papillary carcinoma

For Indeterminate Nodules Additional Relevant Factors That Would Encourage FNA

- Family history of thyroid CA
- Previous radiation exposure
- Younger age
- Larger size of nodule

Worrisome for Malignant

FNA


Solid with irregular margins


Solid with micro Ca**


Solid with micro Ca**


Solid with micro Ca**


Fine and coarse Ca**


Solid with Coarse Ca**


Cystic with solid elements and Ca**


Solid with micro and peripheral Ca**

BTA Guidelines

Guidelines for the management of thyroid cancer

Third edition

Perros P, Colley S, Boelaert K, Evans C, Evans RM, Gerrard GE, Gilbert JA, Harrison B, Johnson SJ, Giles TE, Moss L, Lewington V, Newbold KL, Taylor J, Thakker RV, Watkinson J, Williams GR

British Thyroid Association

July 2014

Article first published online: 3 JUL 2014 | DOI: 10.1111/cen.12515

Clinical Endocrinology, 2014; 81: 1–122.

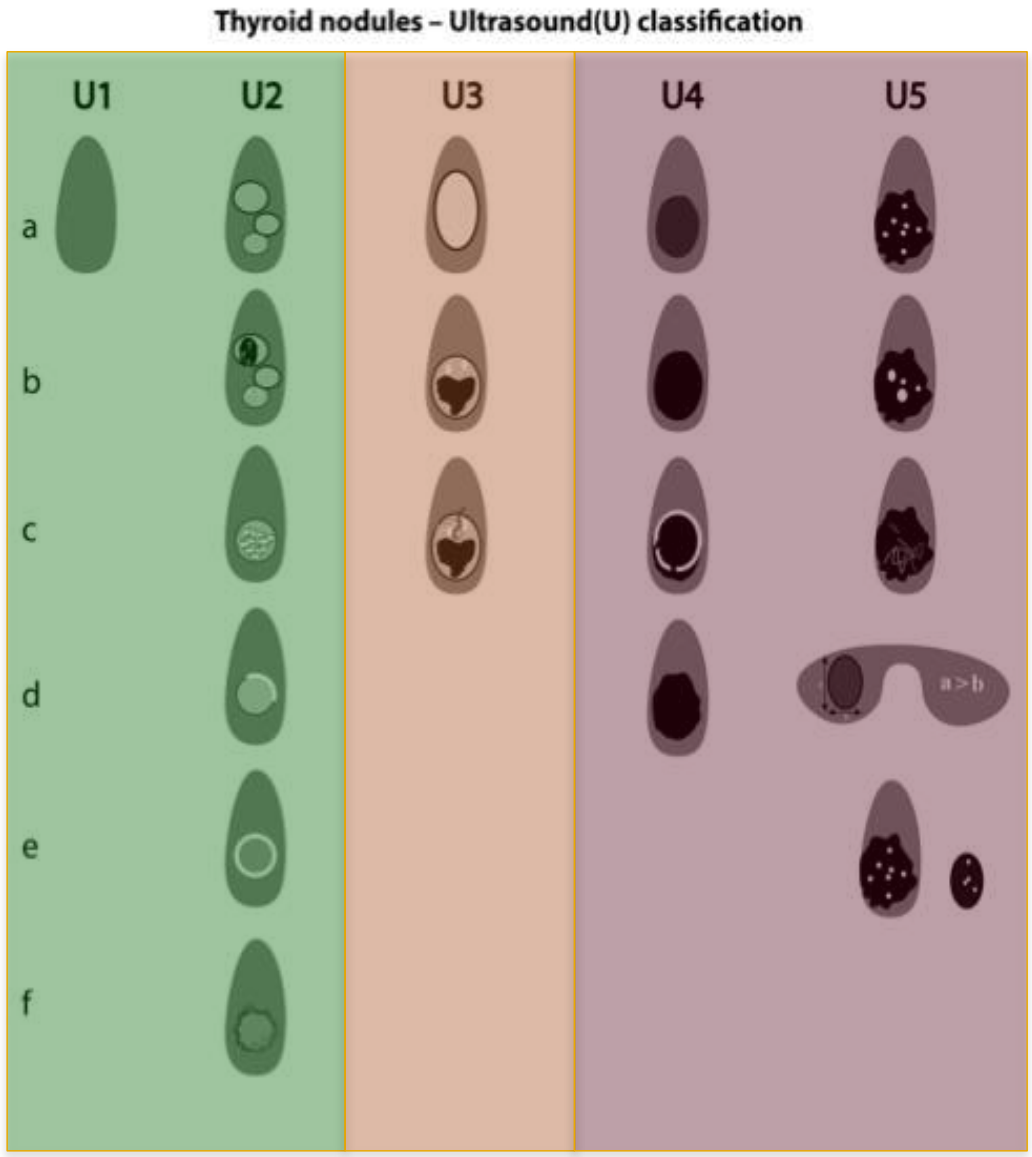
BTA Guidelines (2007)

- *Ultrasound is rarely of use in assessment of thyroid nodules. It may help guide FNA.*

BTA Guidelines (2014)

- Separate chapter on thyroid nodule US
- Rationalise thyroid US / FNA
  - Suggested standards for reports
  - Indications for FNA
  - Based upon US scoring system
  - U1 – U5
  - Follow up based upon US appearances

BTA Guidelines – *"U Classification"*



U1. Normal.

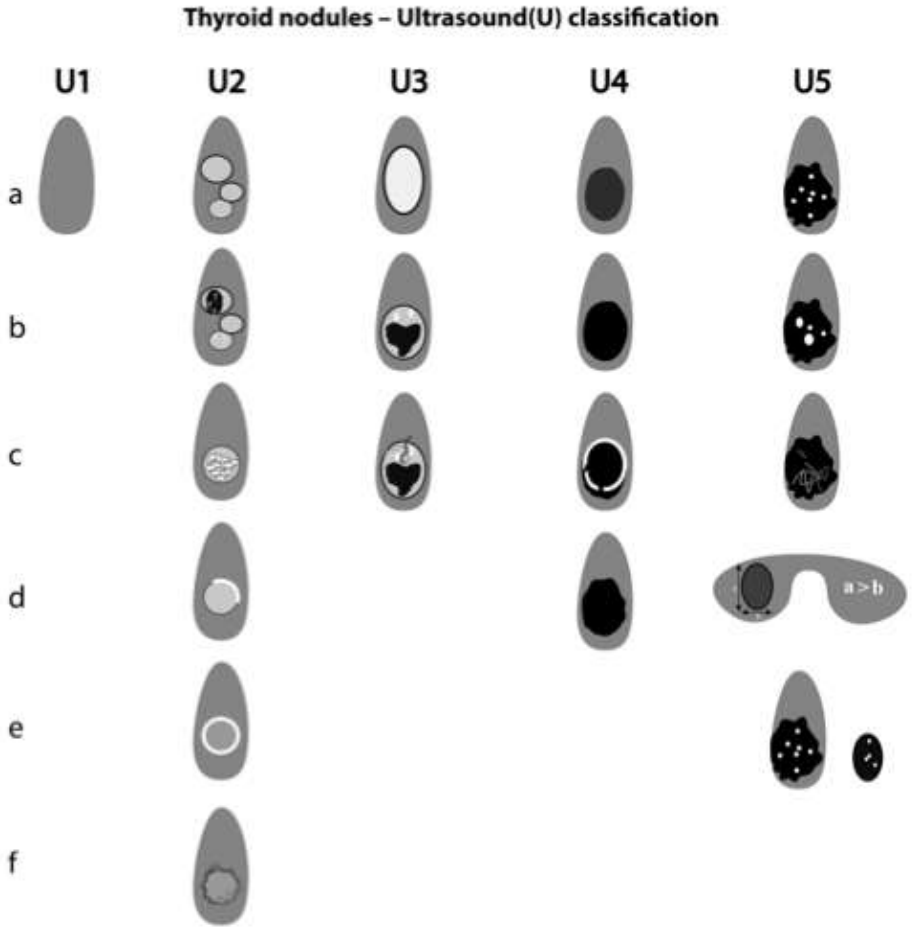
U2. Benign:
(a) halo, hyper- / iso-echoic
(b) cystic change +/- ring down sign (colloid)
(c) micro- cystic / spongiform
(d & e) peripheral egg shell calcification
(f) peripheral vascularity.

U3. Indeterminate/Equivocal:
(a) homogenous, hyper - echoic (markedly), solid, halo (follicular lesion).
(b) ? hypo-echoic, equivocal echogenic foci, cystic change
(c) mixed/central vascularity.

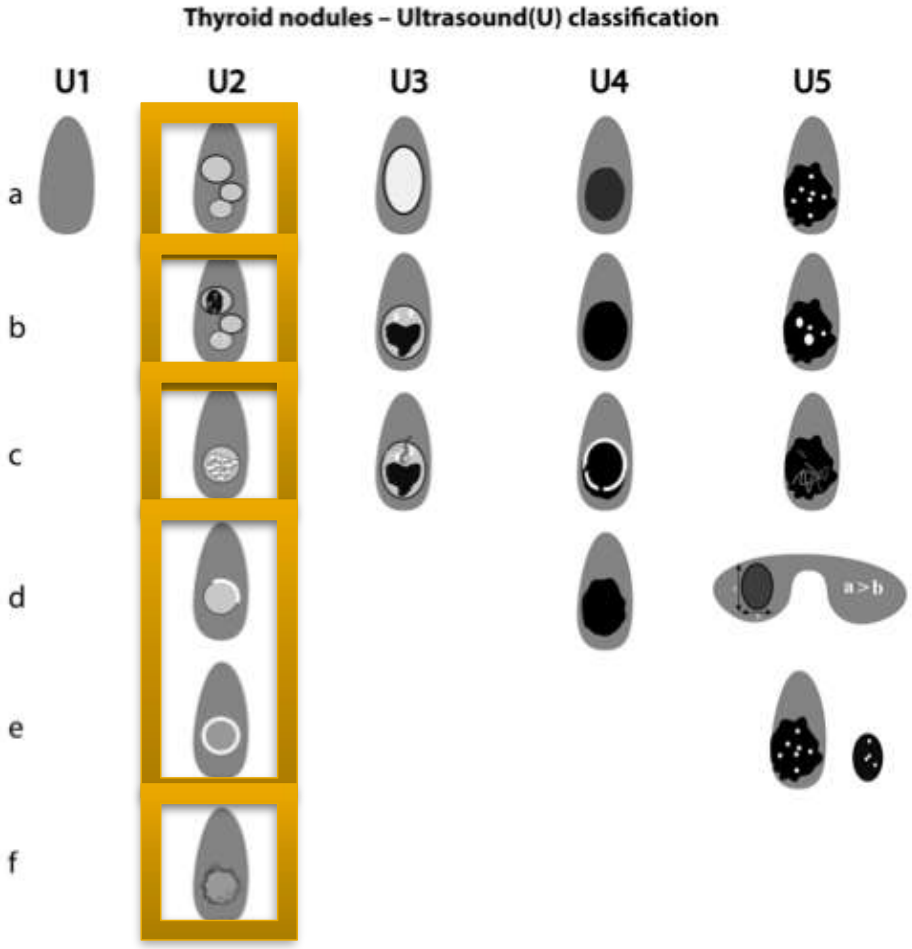
U4. Suspicious:
(a) solid, hypo-echoic (cf thyroid)
(b) solid, very hypo-echoic (cf strap muscle)
(c) disrupted peripheral calcification, hypo-echoic
(d) lobulated outline

U5. Malignant
(a) solid, hypo-echoic, lobulated / irregular outline, micro-calcification. (? Papillary carcinoma)
(b) solid, hypo-echoic, lobulated/irregular outline, globular calcification (? Medullary carcinoma)
(c) intra-nodular vascularity
(d) shape (taller >wide)
(e) characteristic associated lymphadenopathy

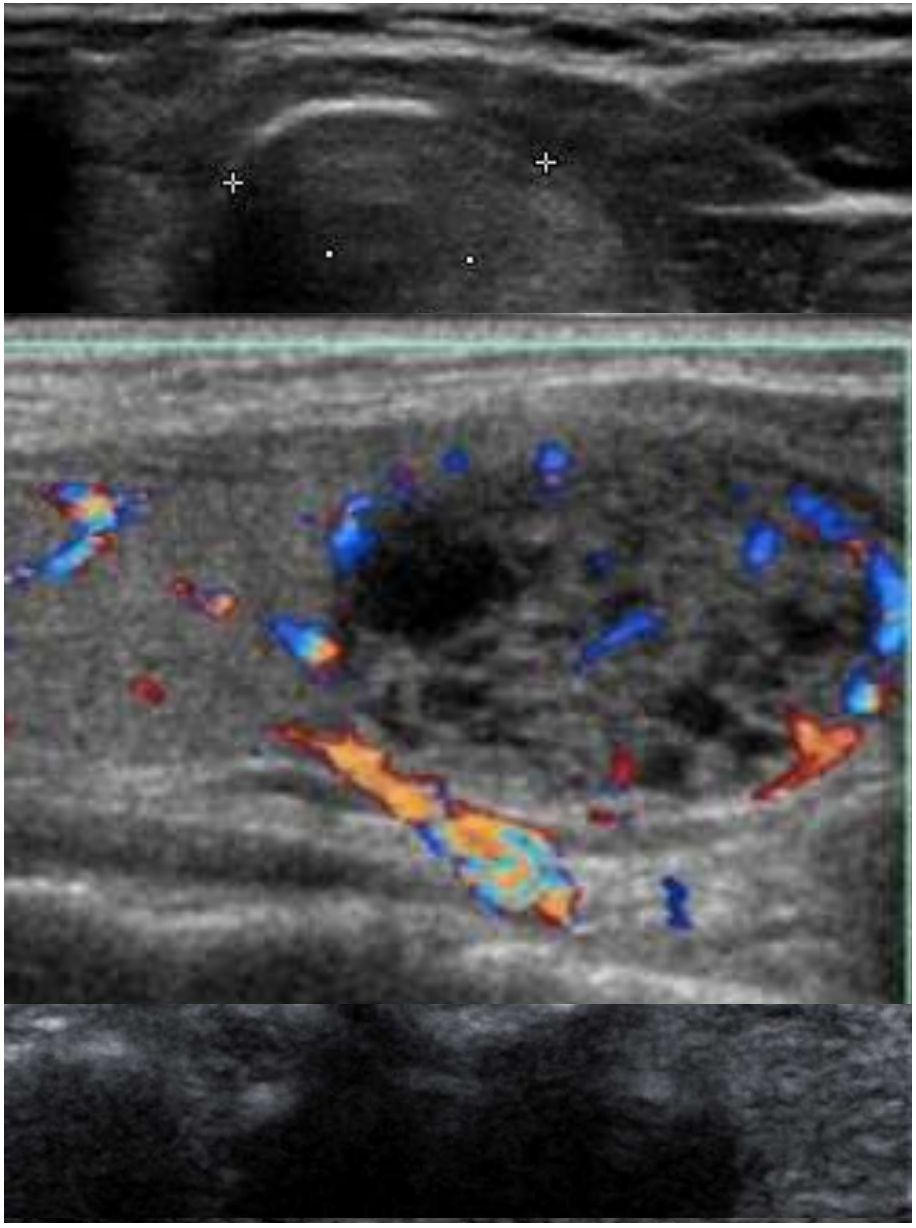
U1 - Normal


Thyroid nodules – Ultrasound(U) classification
U1
U2
U3
U4
U5
a
b
c
d
e
f
a > b

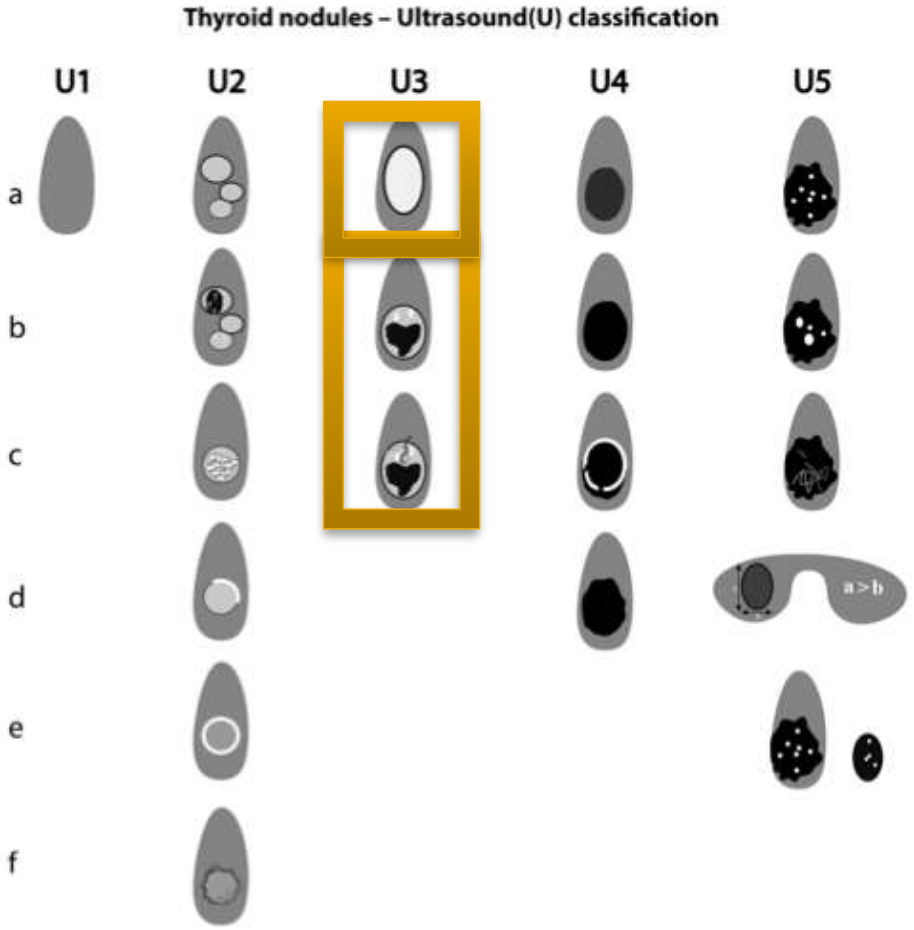
U2 - Benign

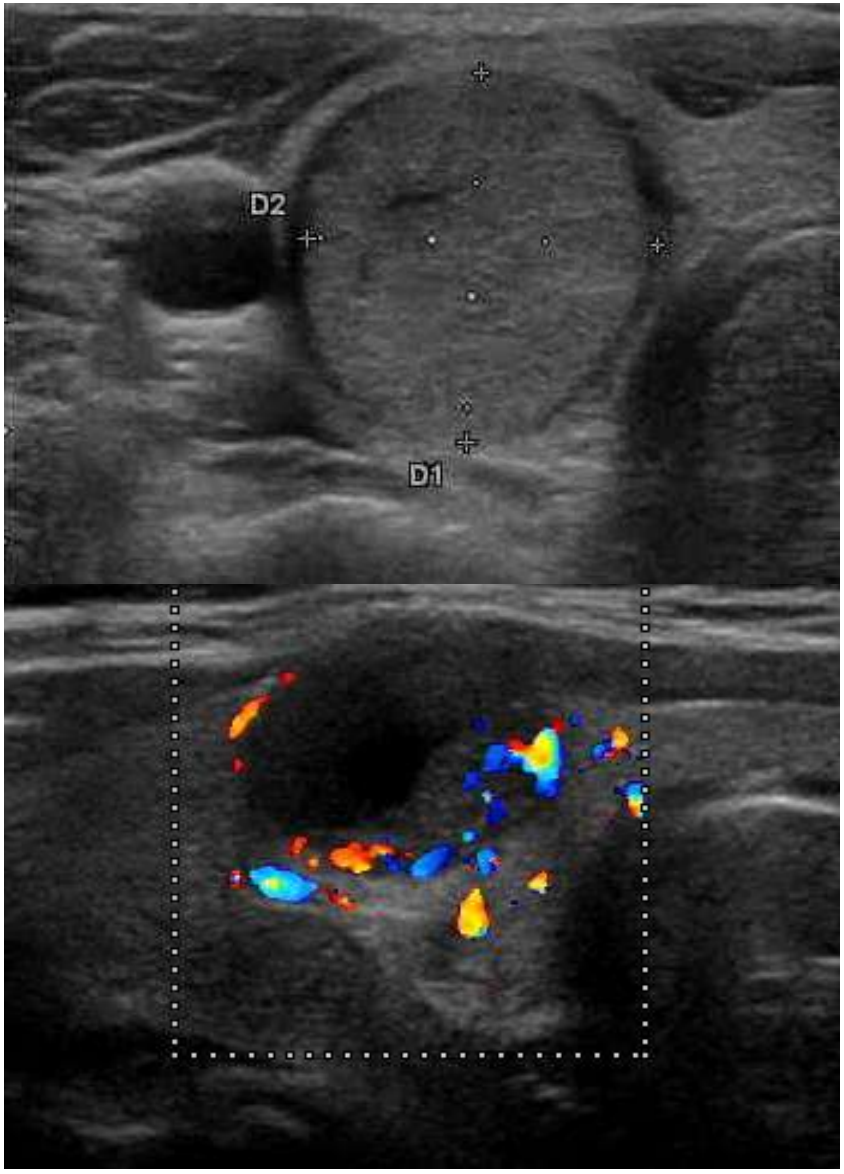


Kim EK, et al. Ultrasonographically Differentiation of Thyroid Nodules: US Differentiation of benign and malignant thyroid nodules. *Radiology* 2008;247(3):762–770.

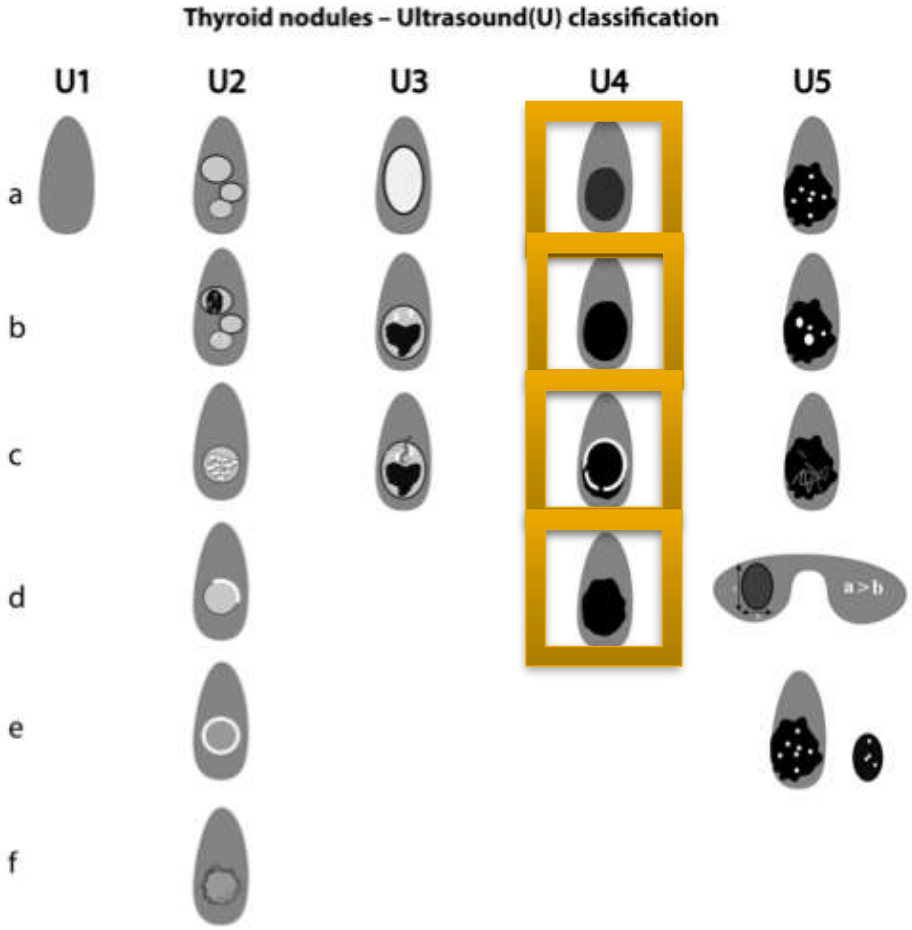


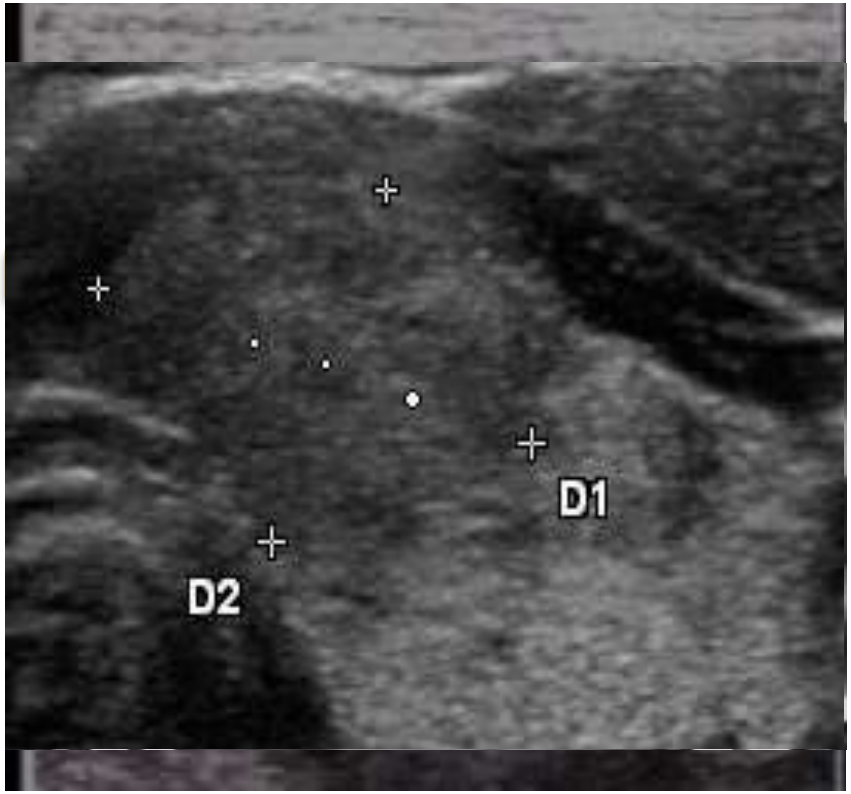
U3 – Indeterminate



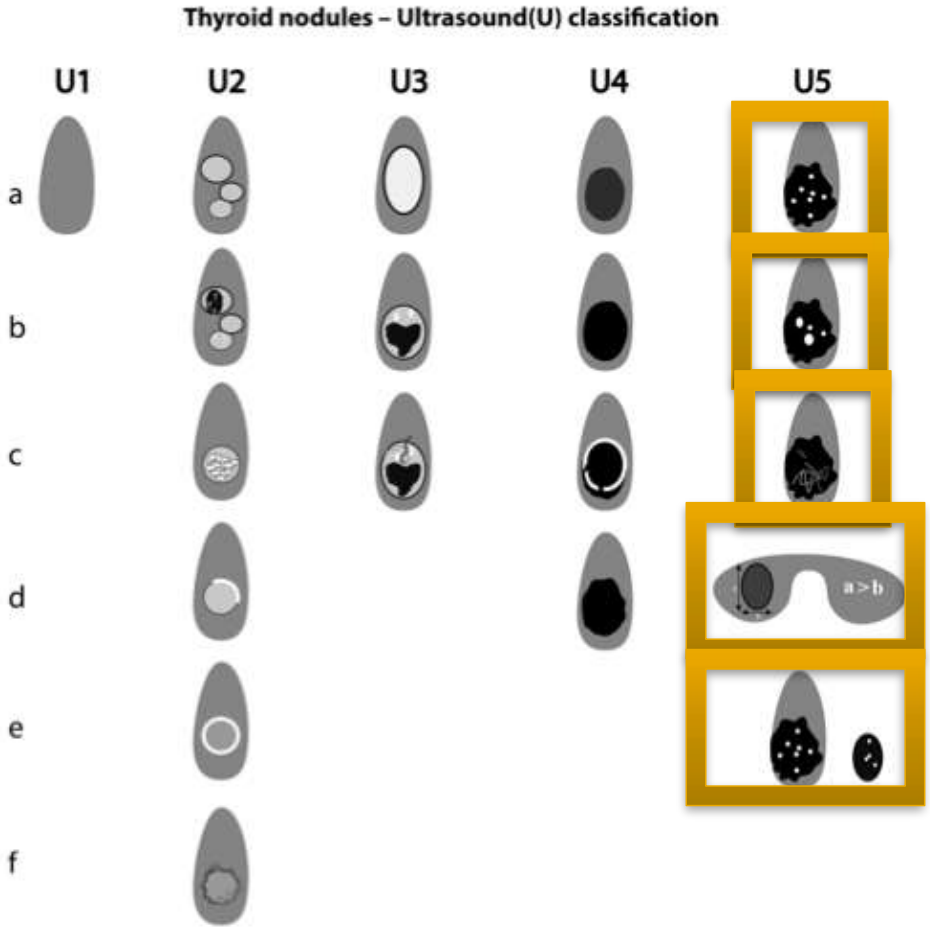


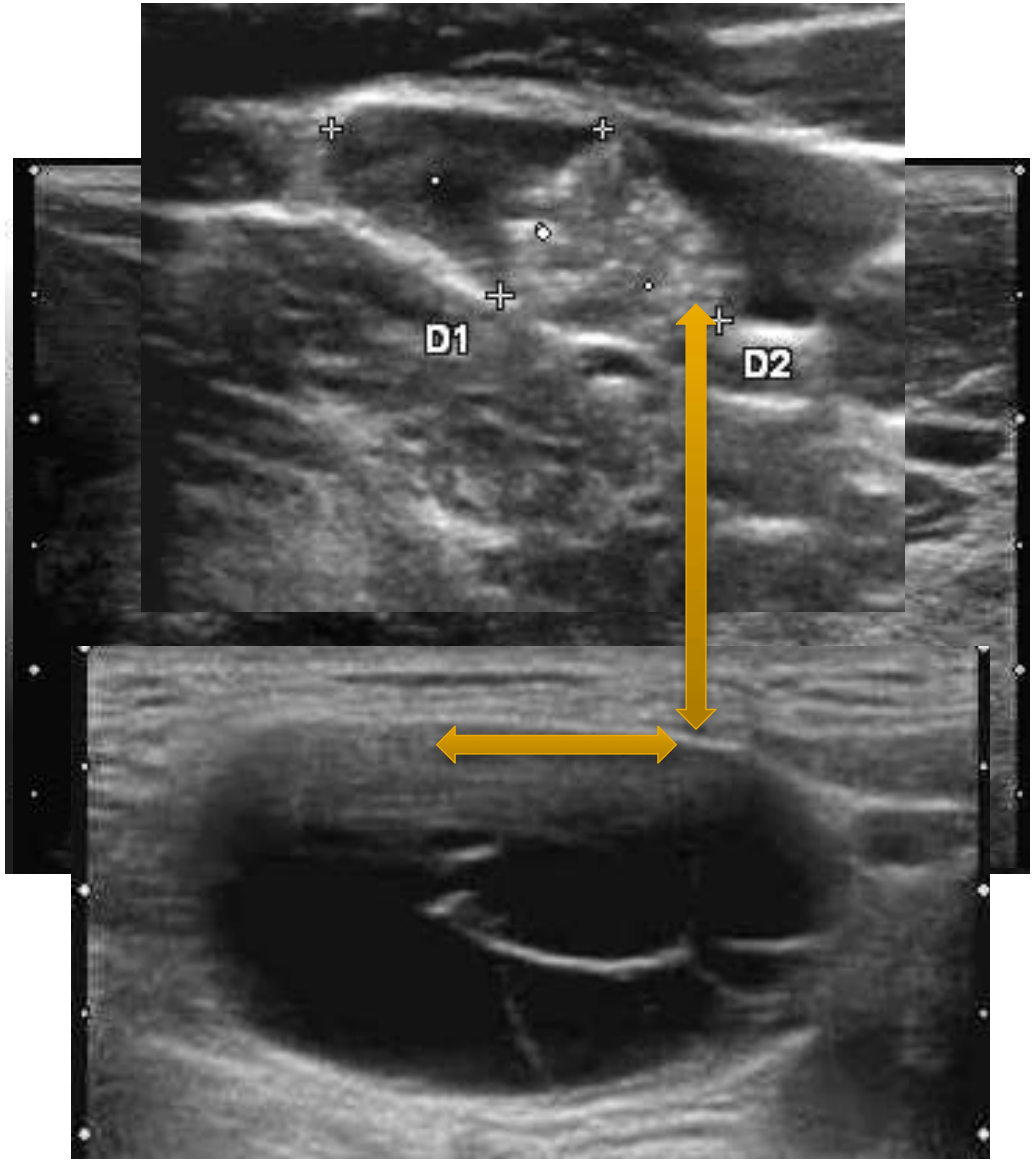
U4 – Suspicious





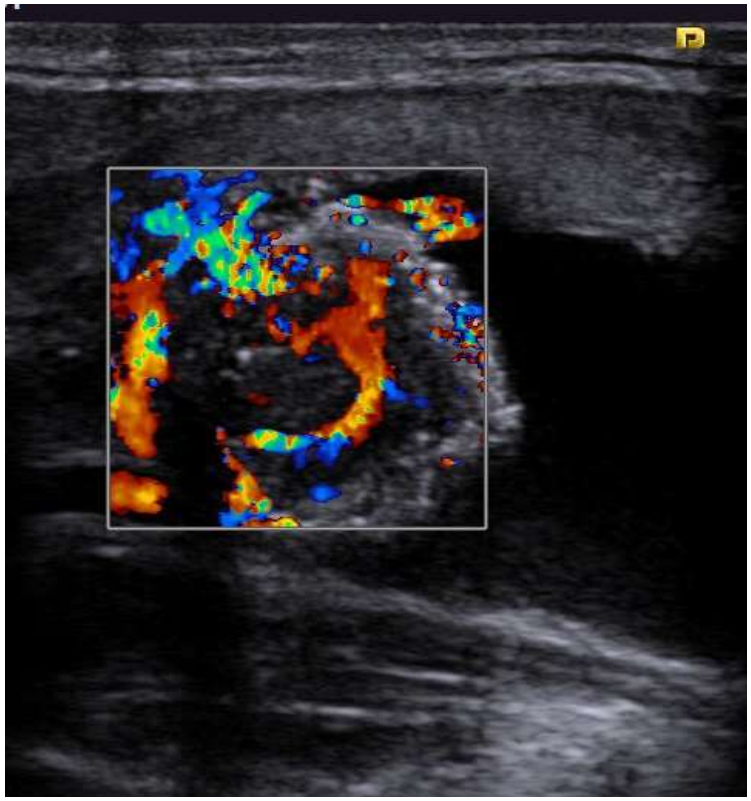
U5 – Highly Suspicious





Kim EK et al. New sonographic criteria for recommending fine- needle aspiration biopsy of nonpalpable solid nodules of the thyroid. *AJR* 2002;178:687-91.

U5 – Highly Suspicious (eccentric cystic papillary cancer)



Park JM et al. Partially Cystic Thyroid Nodules: Ultrasound Findings of Malignancy. *Korean J Radiol* 2012: 13(5): 530-535.

Ultrasound Rating (U1 – U5)

- FNA any indeterminate or suspicious / malignant nodules
- FNA of U3 – U5
- U3 – most will be benign, but follicular lesions are included, and the occasional cancer may be present

Common Misunderstandings

- Nodule size
- Dominant Nodule FNA
- Follow up post benign FNA
- Nodule growth

Nodule Size

- Nodules > 4cm have been claimed as having malignancy rates > 20%
- *Nodule size > 4cm increases neither the false negative rate of FNA, nor the rate of malignancy*

Shrestha M, Crothers BA, Burch HB. The impact of thyroid nodule size on the risk of malignancy and accuracy of fine-needle aspiration: a 10-year study from a single institution. *Thyroid*. 2012;22:1251-6

Nodule Size

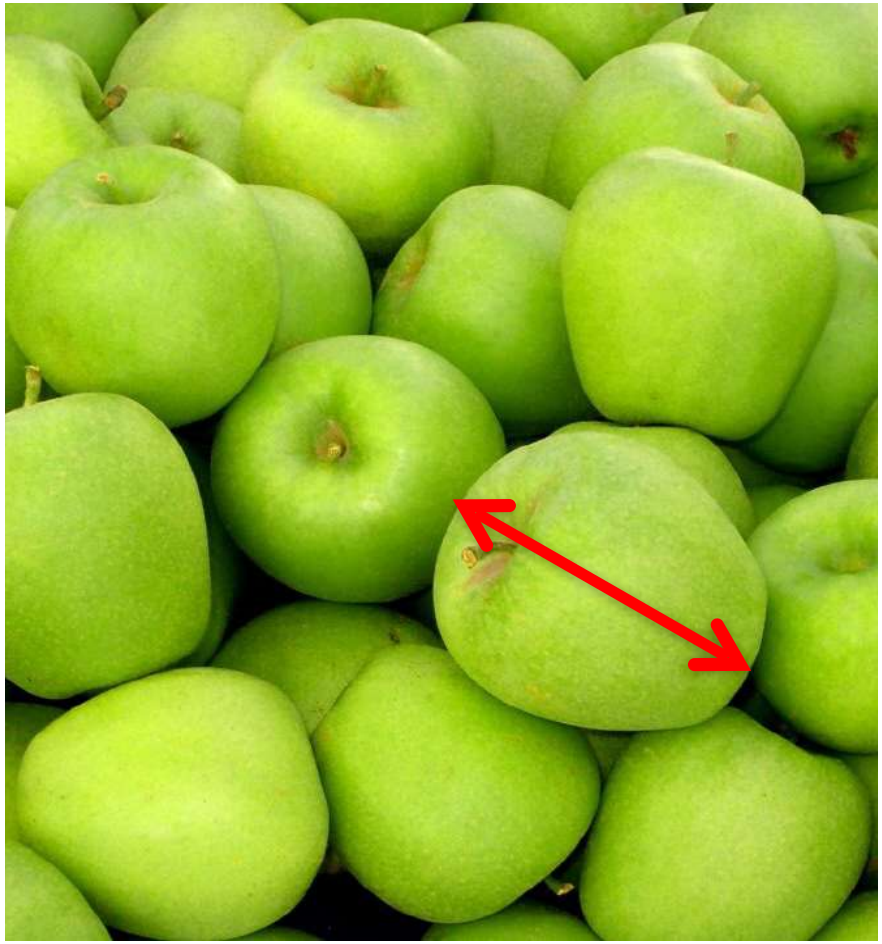
- 661 nodules > 3cm diameter
- US and FNA are accurate in nodules > 3cm.
- *US features are still predictive even with larger nodule size*

Yoon JH, Kwak JY, Moon HJ. The diagnostic accuracy of ultrasound guided fine needle aspiration biopsy and the sonographic differences between benign and malignant thyroid nodules 3cm or larger. *Thyroid* 2011: 21(9): 993 – 1000

Dominant Nodule FNA

- *FNA of a dominant nodule is a common but mistaken practice*
  - Decision to FNA should be based upon US appearances.
  - Selecting nodules purely on size criteria encourages lazy / incomplete assessment

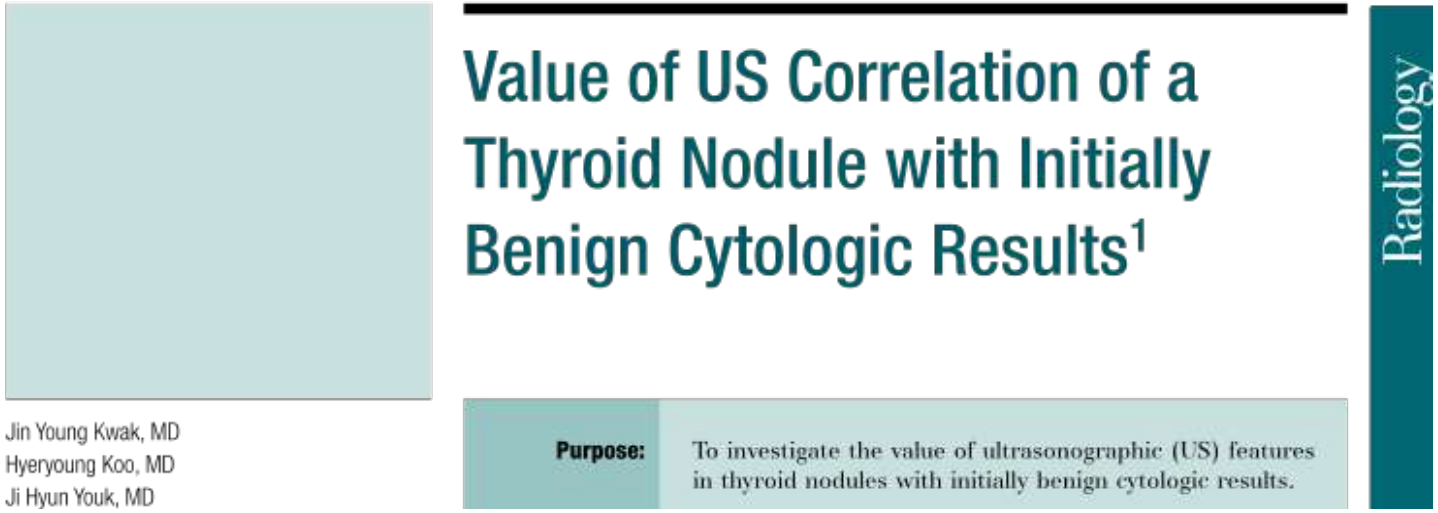
The Apple Analogy



Follow Up Post FNA

- 2007 Guidelines
  - Thy 2 (benign FNA) requires repeat in 6 – 12 months
  - Quoted as 6 – 8 % false negative

Follow Up Post FNA



Value of US Correlation of a Thyroid Nodule with Initially Benign Cytologic Results[1]

Jin Young Kwak, MD
Hyeryoung Koo, MD
Ji Hyun Youk, MD

Purpose: To investigate the value of ultrasonographic (US) features in thyroid nodules with initially benign cytologic results.

Radiology

Radiology 2010. 254 (1): 292 - 300

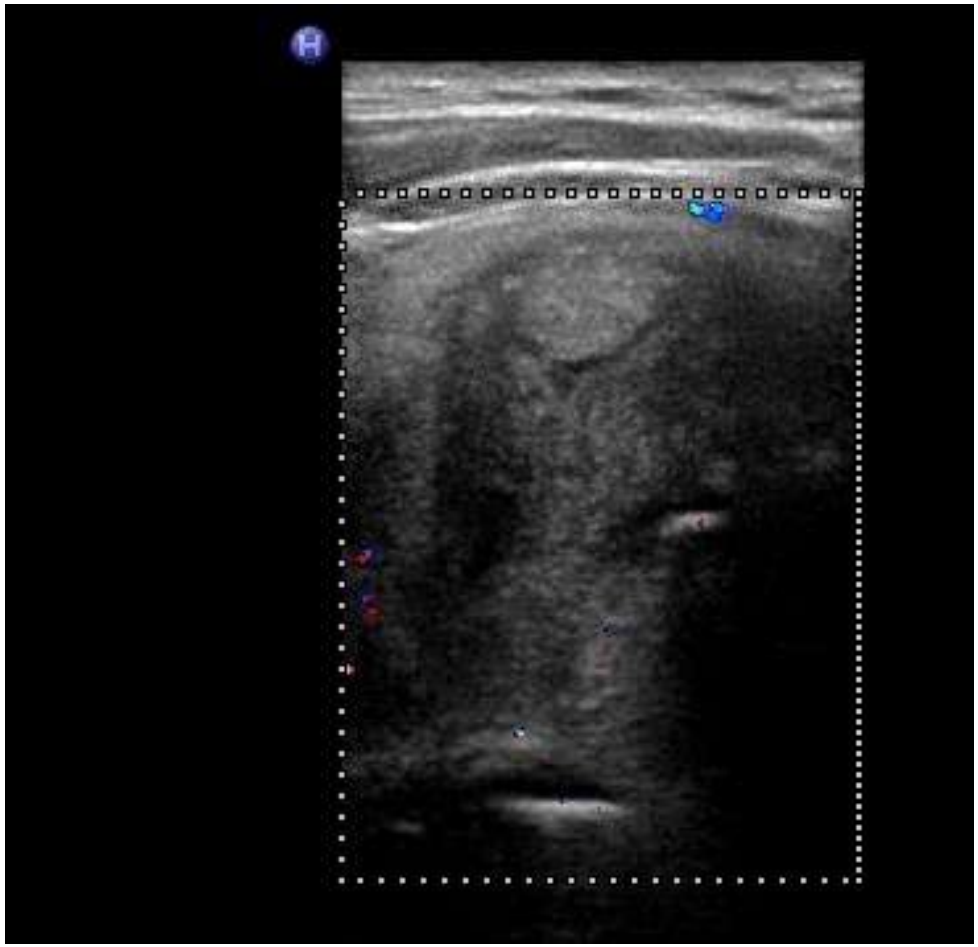
1343 nodules with US, FNA, pathological correlation

Total:	Benign 98.1%	Malignant 1.9%
Benign initial US + Thy 2 FNA:	Benign 99.4%	Malignant 0.6%
Suspicious initial US + Thy 2 FNA:	Benign 79.6%	Malignant 20.4%

Follow Up Post FNA

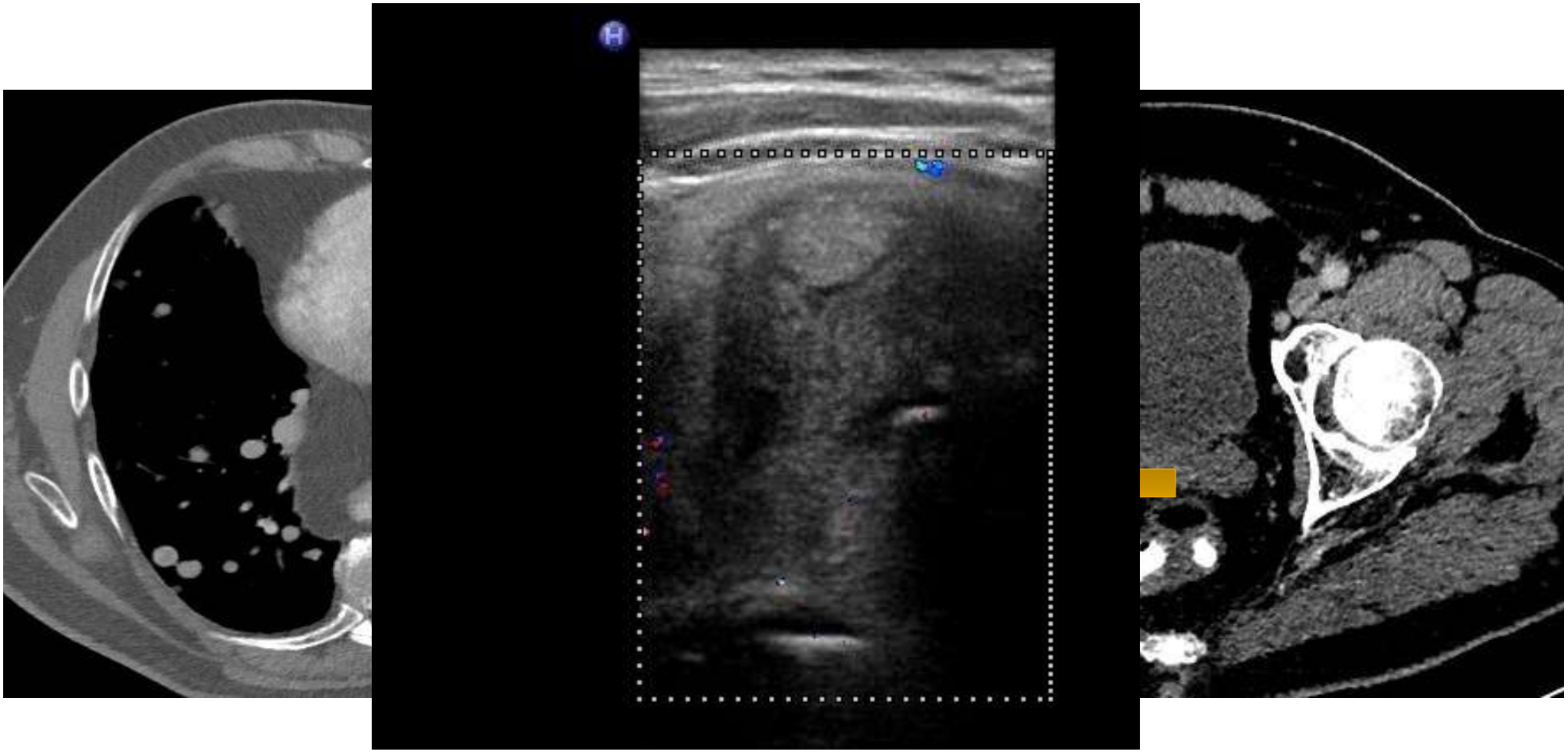
- Benign US and benign FNAC does not need repeating after 6 – 12 months
  - Low cost effectiveness
  - Increased anxiety
- Suspicious US and Thy 2 must be repeated as malignancy rates are significant

Is this relevant…???



- FNAd
- Thy 2 result 2011
- No further f/u

2014 … Yes it is!!!!!



Follow Up Post FNA

- Long term follow up of benign nodules
  - Associated with increased US studies
  - Associated with increased FNA rates
  - *No improvement in malignancy detection rates*

Lee S, Skelton TS, Zheng F. Biopsy proven benign thyroid nodule: is long term follow up necessary. *J Am Coll Surg* 2013, 217(1): 81 – 8.

Nodule Growth

- Presence or absence of growth is not an indicator of malignancy or benignity
- Interval growth has low PPV for malignancy

Nodule Growth

- 294 / 330 Thy 2 nodules enlarged
- Average 15% growth
- 74 nodules had significant growth (≈ 69%)
- Re-FNA showed cancer in only 1 / 74.

Alexander EK et al. Natural History of Benign Solid & Cystic Thyroid Nodules. *Ann Int Medicine* 2003; 138: 315 - 318

- *Growth of nodules is an expected finding in benign thyroid disease*

US Standards, Images & Reports

- Radiologist, sonographer, surgeon, endocrinologist
- Formal images, recorded on PACS, with appropriate formal report on RIS system
- Training in accordance with RCR Guidelines / Non–radiologist US Training Document
- Assessment of any indeterminate or suspicious nodules

TABLE 4.4
Suggested features to consider/include in US reporting/assessment of thyroid nodules:

Relevant Nodule Size:	
Nodule Composition:	Solid, cystic, mixed solid /cystic, micro-cystic/spongiform.
Cystic Component:	? Ring down sign - colloid
Echogenicity:	Markedly hypo-echoic, hypo-echoic, iso-echoic, hyper-echoic
Calcifications:	Micro-calcification, macro-calcification, rim / egg shell
Margin:	Well defined, irregular/lobulated, spiculated
Taller than Wide:	AP> TR : Y / N
Halo:	Regular / continuous, interrupted, absent
Colour flow:	Central, peripheral, mixed, none
Extent:	Retrosternal extension / tracheal deviation
Classification:	Benign (U2), equivocal / indeterminate (U3), suspicious (U4), malignant (U5)
Lymphadenopathy:	Suspected malignancy – ? metastases: anatomical location/levels
Biopsy:	FNAC / core biopsy, needle gauge, number of passes. Location of nodule biopsied. Complications : Y/N.

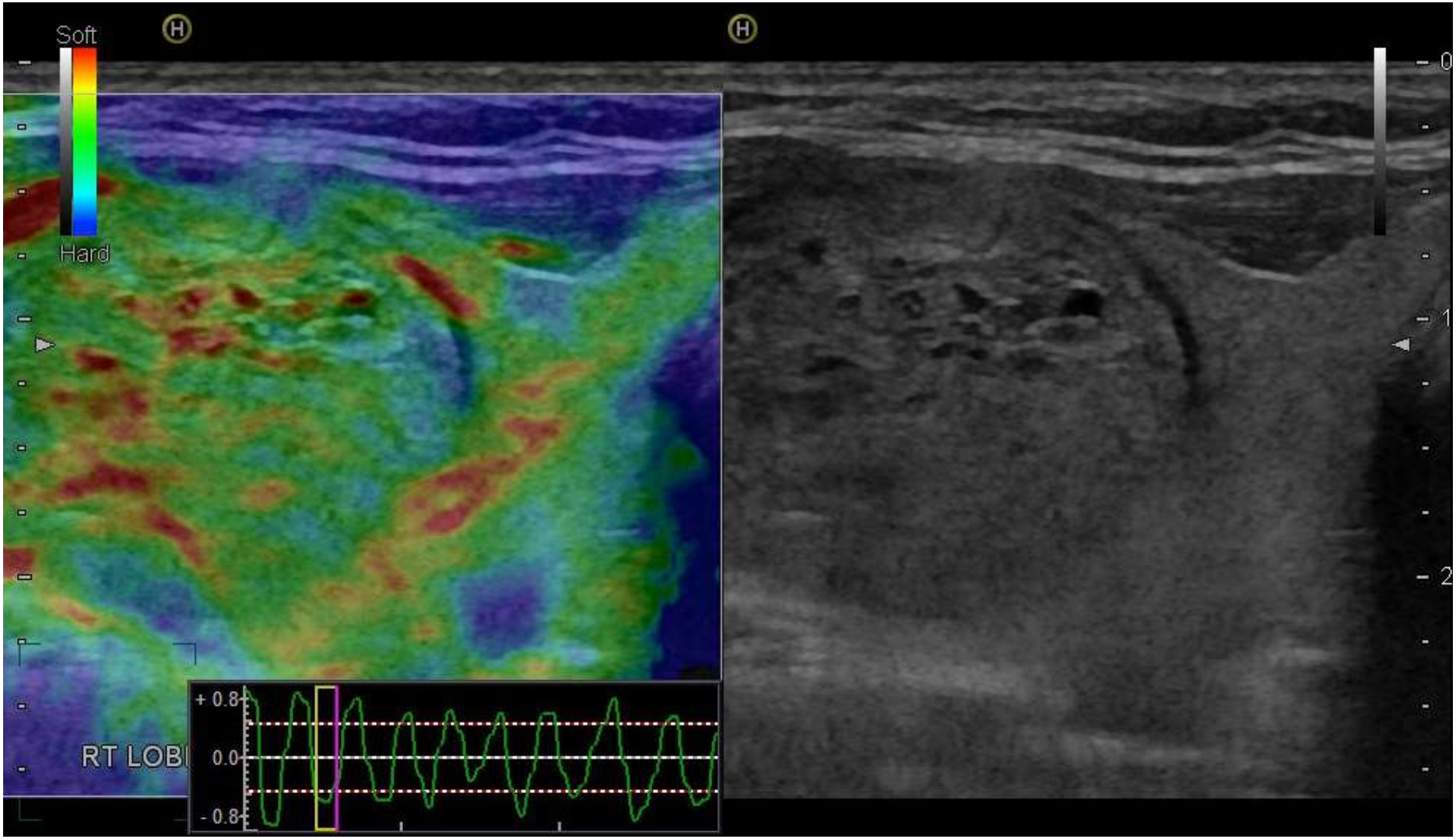
Ultrasound Standards

- Interest / regular practice of thyroid imaging
- Participation at Thyroid MDT
- US images / report stored on PACS system
  - Report attached to images
  - Assess the likelihood of cancer
  - Regular audit of cases / FNA results
- *MINIMUM STANDARD OF PRACTICE*

B mode performance

- Can we improve US performance?
- *Can we increase the NPV?*

Elastography for reassurance…



Reference	Publication year	Case number	NPV (%)	
			US	USE
Veyrieres et al. [21]	2012	297	95.0	99.3
Shweel et al. [23]	2013	66	63.1	98.8
Russ et al. [24]	2013	4,550	99.7	99.8

Kwak JY, Kim E-U. Ultrasound elastography for thyroid nodules: recent advances. Ultrasonography 2014; 33: 75 - 82

Combining US and Elastography

1. Veyrieres JB, Albarel F, Lombard JV, et al. A threshold value in Shear Wave elastography to rule out malignant thyroid nodules: a reality? Eur J Radiol. 2012;81(12):3965-3972

Summary

- US is very good for assessing thyroid nodules
- US + ES is even better for NPV
- BTA Guidelines
  - Rationalise use of US and FNA
  - Reduce unnecessary FNA and hence diagnostic hemi rates
  - Scoring systems – training, performance, audit

Thankyou