Advances in Endobronchial Ultrasound

DM Seminar

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Content

1. Basic Principles
2. Tissue Harmonic Imaging
3. Contrast USG
4. Elastography
5. i-scan/ Misc
6. H flow/ Fine flow
7. Newer available EBUS bronchoscopes

Section 1. Basic Principles

Ultrasound basic principles

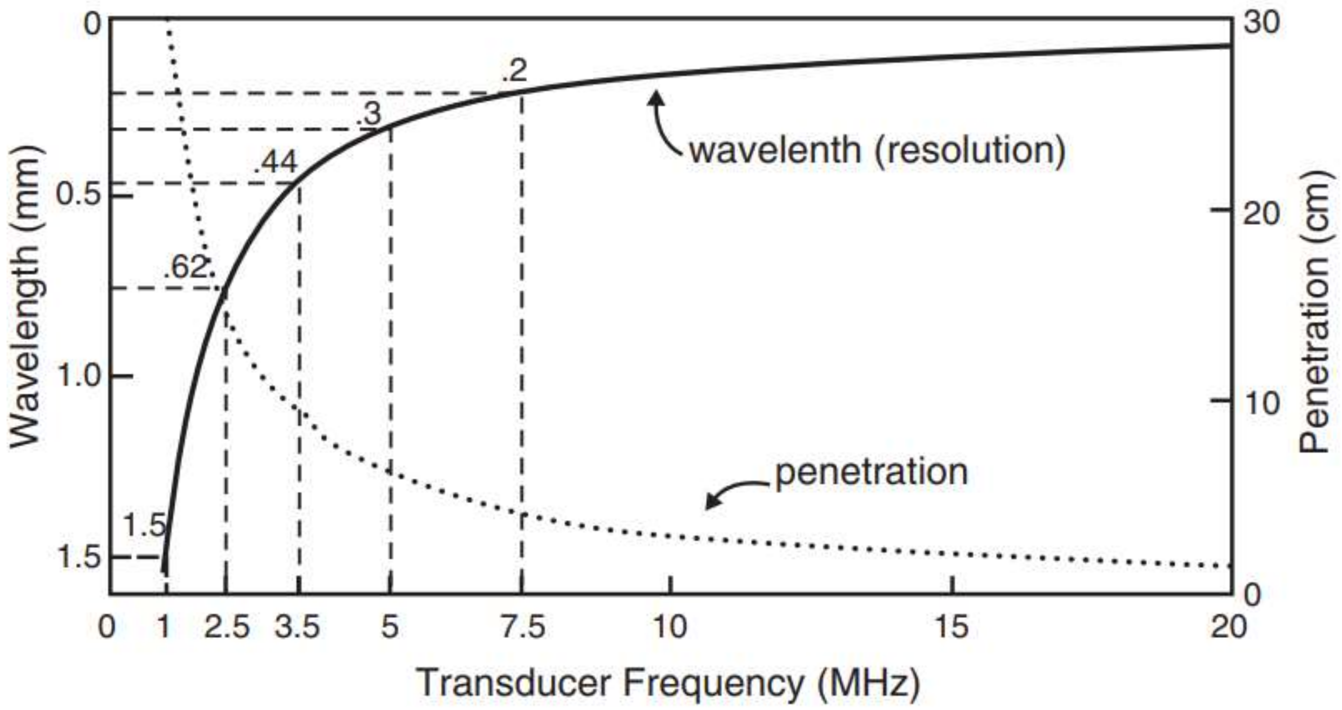
- Imaging modality which uses pulse-echo approach
- Transmits small pulses of echo from a transducer into the body.
- As the ultrasound waves penetrate body tissues of different acoustic impedances, some are reflected back to the transducer
- Echo signals returned from many sequential coplanar pulses are processed and combined to generate an image

3 modes

- A mode: Amplitude mode
- B Mode: Brightness mode 2 D mode
- M Mode: Motion Mode

USG frequencies

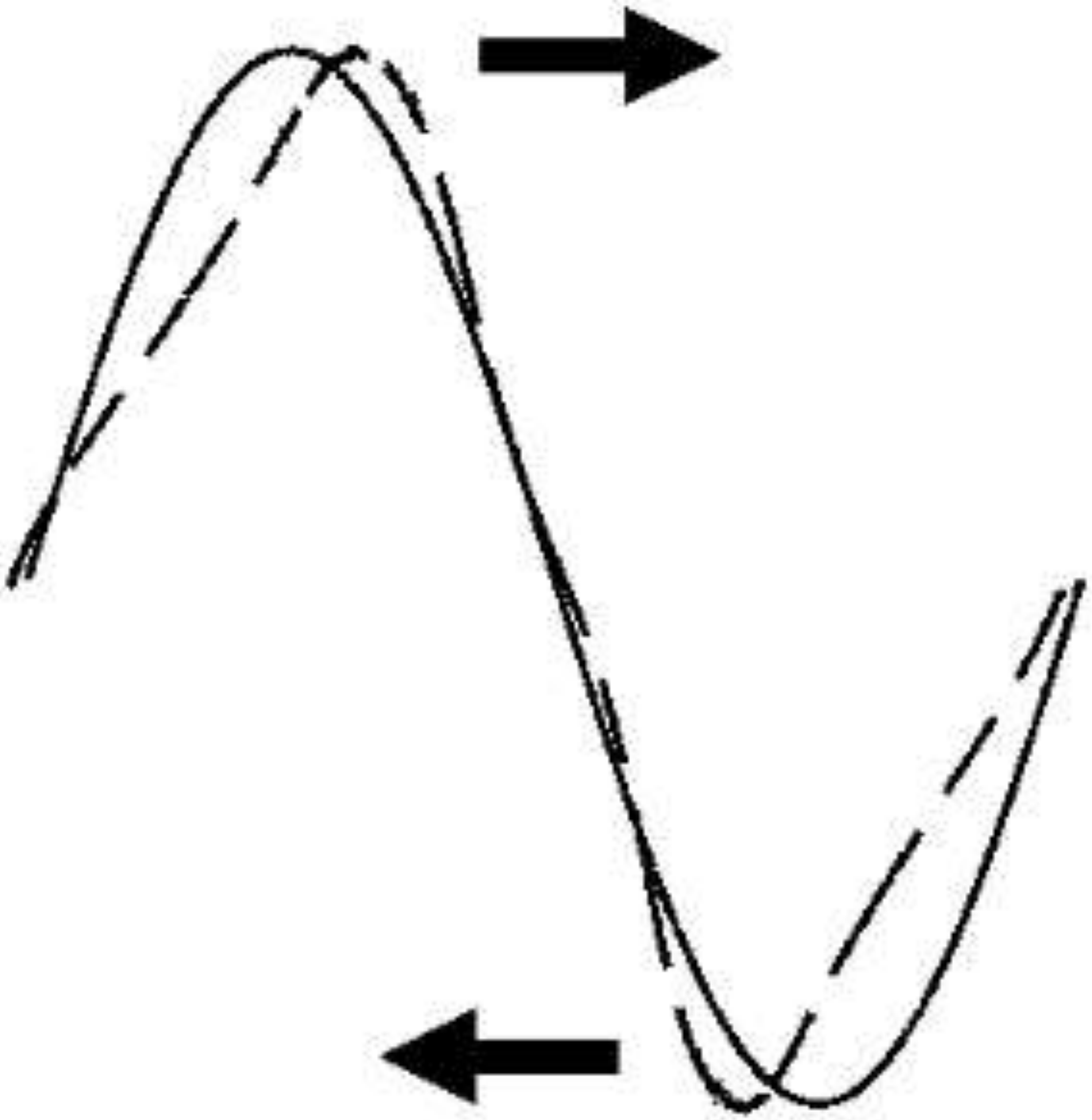
- High Frequency transducers for superficial structures (10 to 15 MHz)
- Low frequency transducers for deeper structures (2 to 5 MHz)



Section 2. Tissue Harmonic Imaging

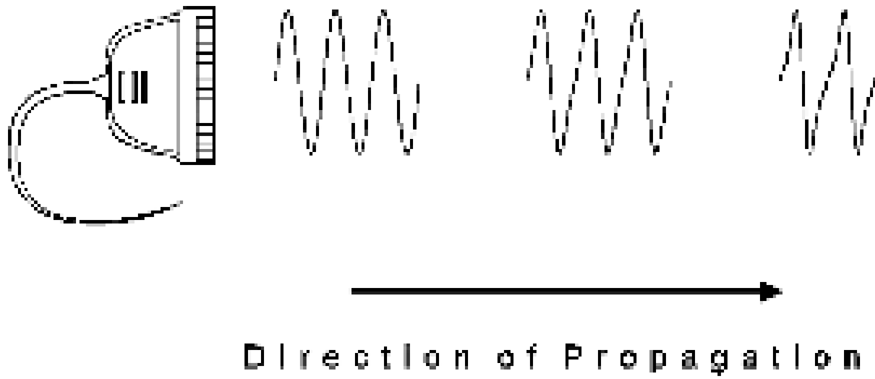
Origin of Harmonics

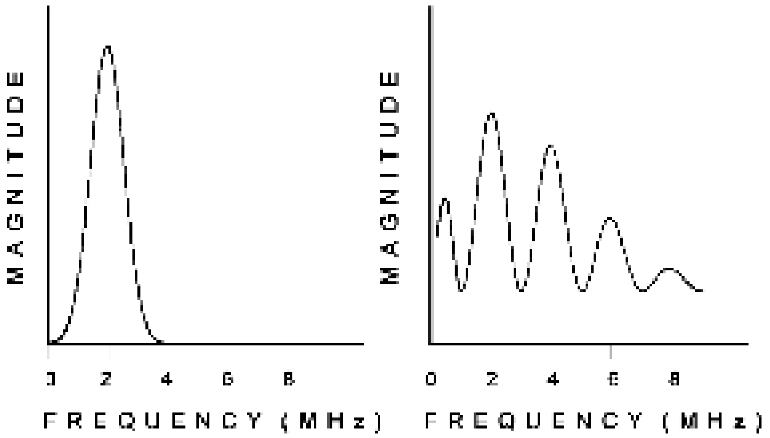
- When wave propagates through
  rarefaction of the tissue
- Compressed tissue will propagat
  original Wave
- Causing distortion of the wave p



On further movement

- As the wave moves farther away from transducer amount of distortion is amplified





- So with propagation into the tissue the frequency of distorted waves generated converts in to multiple of the fundamental frequency

Characteristics of newer Waves

- Nonlinear propagation
- The high-frequency components exhibits more rapid pressure amplitude loss
- These waves are than reflected back to the Transducer

Summarizing…

- Due to non linear propagation of the acoustic wave through the tissues (Compression and rarefaction) new wave frequencies aka harmonics are generated
- They are multiples of the fundamental frequency
- Deeper the tissue, more the harmonics that are generated
- Generation of harmonics happens after compromising over the amplitude of the wave due to dissemination of the acoustic energy

Harmonic signal detection

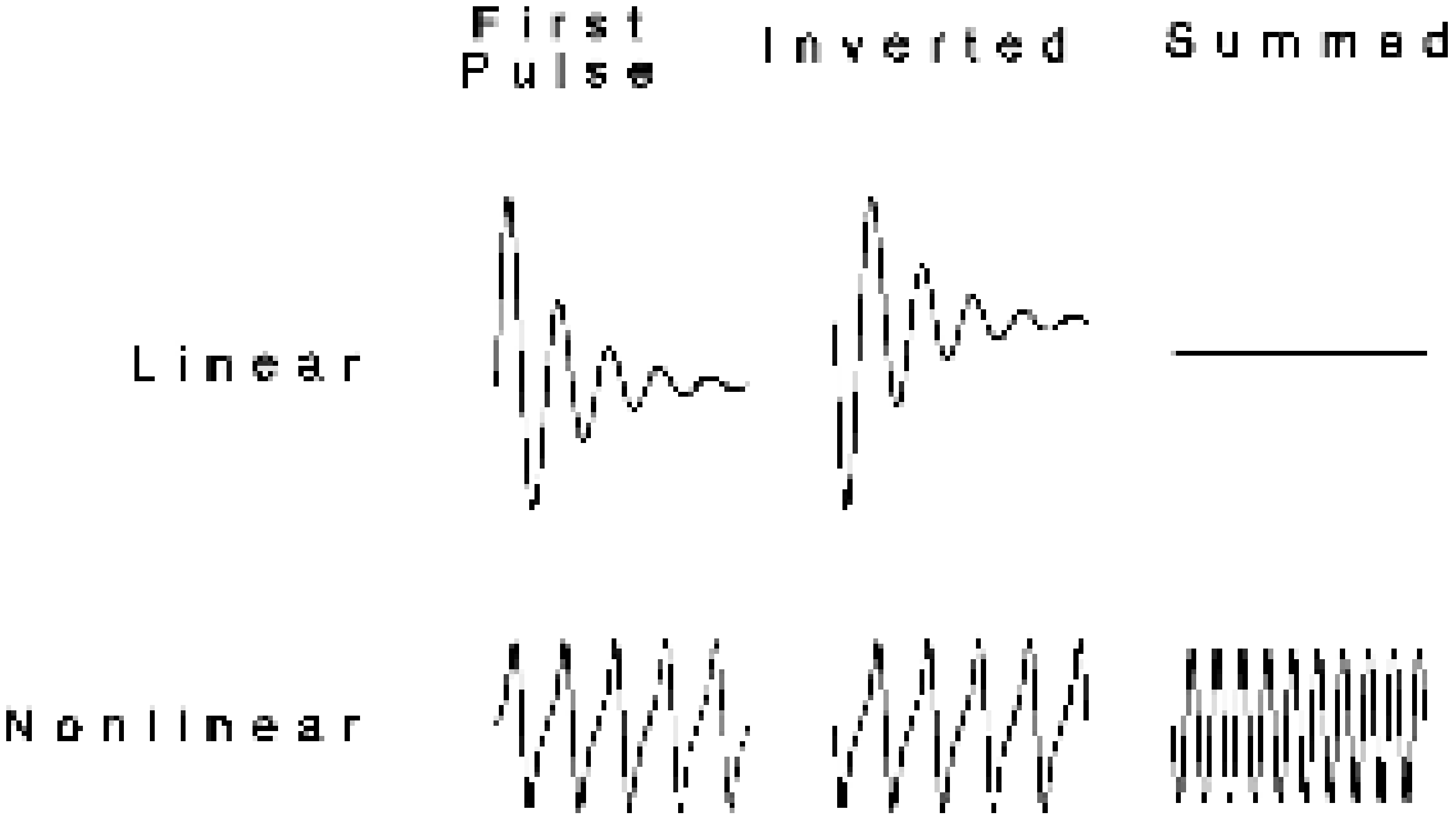
- Only second harmonic can be imaged because the transducer which produced fundamental harmonic has limited reception module
- So low-noise, wide dynamic range receiver is necessary to preserve and process the relatively weak signal
- Two methods

1. Harmonic Band Filtering

- The returning echo has a fundamental frequency component and a harmonic frequency component
- A Filter is applied to remove the fundamental echo signal
- Thus only the tissue harmonic component is processed for image formation.

2. Pulse Phase inversion

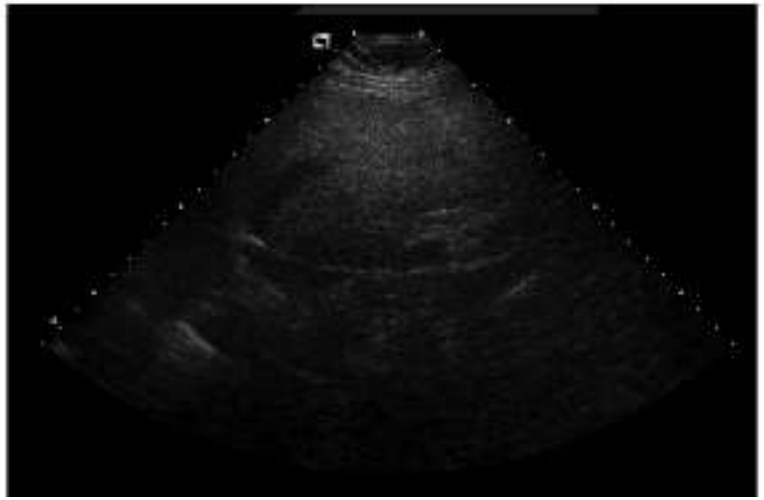
- Two-pulse
- The secon
- The echo- ... e signal from the s
- The recei ... mmed.
- For linear ... ne amplitude ... when summed.
- If nonlinea ... same proportio



Examples of THI

A

B



A

B

Advantages of THI

- Decreased reverberation and side lobe artifacts
- Increased axial and lateral resolution
- Cyst clearing
- Increased signal to noise ratio
- Improved resolution in patients with large body habitus

Disadvantages of THI

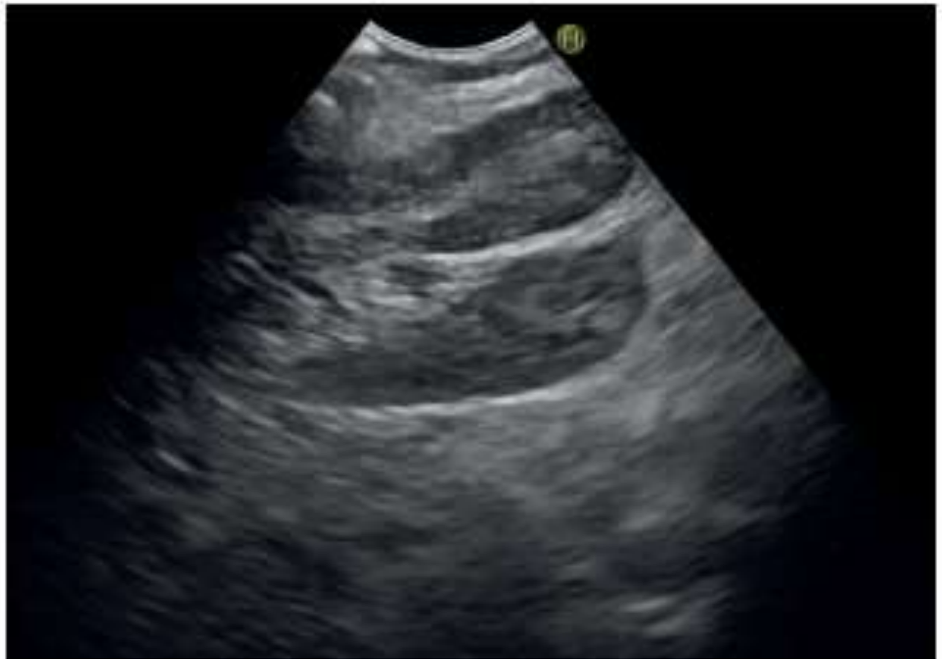
- Only a small fraction of the transmitted pulse energy is converted into the second harmonic
- THI is less sensitive than conventional B-mode for moving organs (Heart).
- Structures located near the transducer are depicted with poor contrast

Use of THI in endoscopic USG

- Role of THI has been evaluated in EUS for studying pancreaticobiliary structures
- One retrospective study analyzed the images obtained from B Mode and THI mode in 29 pts
- They concluded that for Cystic lesions THI was superior to B Mode in Visualizing the boundary, septum, nodules, and total image quality ($P < 0.05$).
- But for solid lesions, there was no significant difference in all the evaluation points between THI and conventional B-mode images.

Matsumoto et al Endosc Int Open. 2016 Jan;4(1):E42-50

Role of THI in EBUS



Broadband Harmonic Imaging

High definition dynamic Tissue Harmonic Imaging (HdTHI) / dynamic Tissue Harmonic Imaging (dTHI)

- Improves spatial resolution and achieves excellent deep area penetration
- Clear boundaries delineation, vascular structures clear of noise and good visualisation of needle tip insertion, are easily achieved with high frame rate

- Currently PENTAX Medical EB19-J10U and Hitachi ultrasound are using THI for better resolution

Studies

- Single clinical trail going on for evaluation of Elastography and THI in mediastinal lymphadenopathy
- NCT02948907
- Sponsored by Heidelberg university
- Was supposed to publish results in May 2017

Conclusion

- THI in addition to B mode imaging adds to the better resolution in the images and enhanced clarity
- Less likely to delineate the cause of mediastinal lymphadenopathy as does not differentiate between inflammatory and malignant LAP
- Lack of evidence to support either claim

Section 3. Contrast Enhanced USG

Ultrasound contrast agents

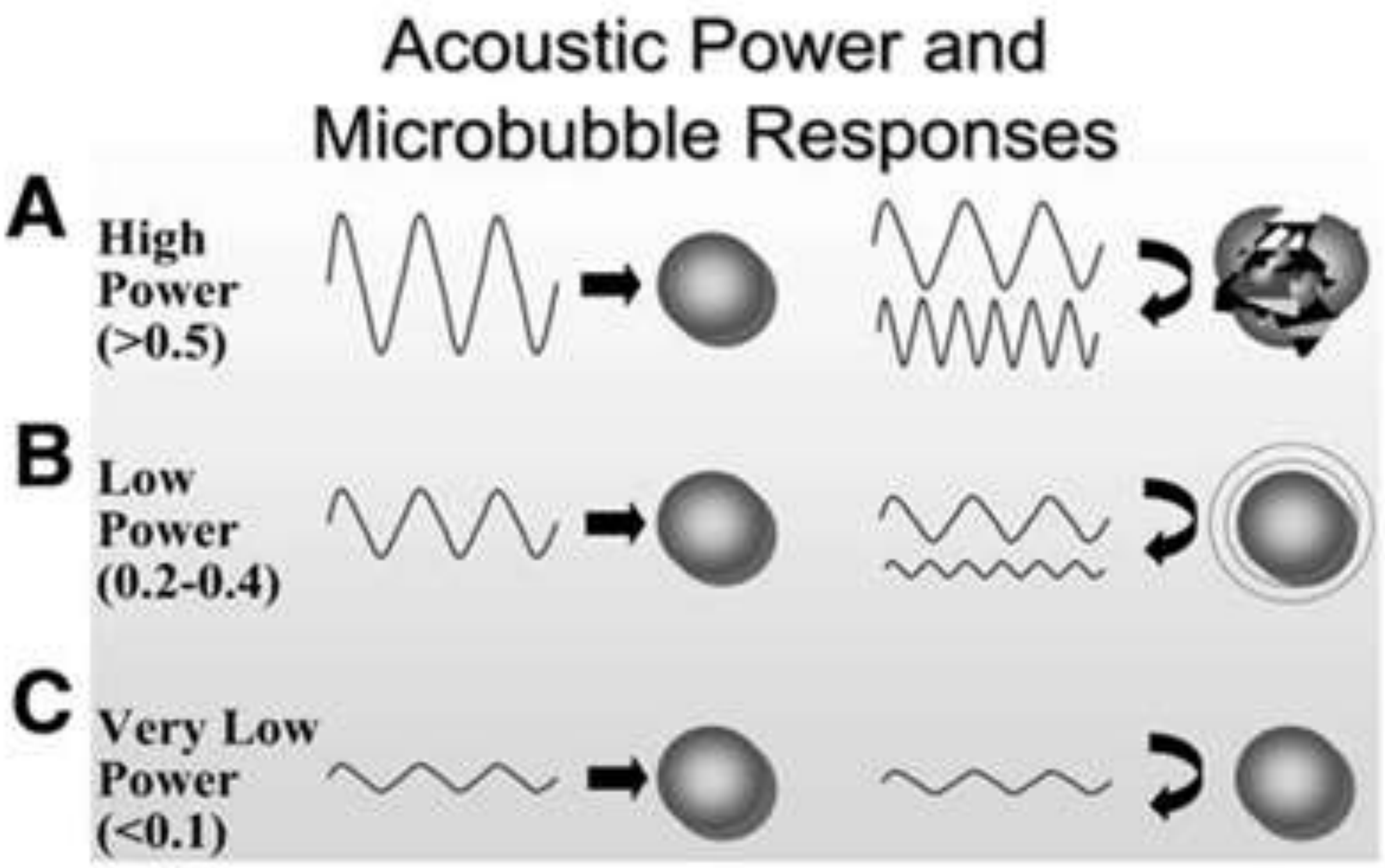
- The general composition: Bubble (gas core) stabilized by a shell.
- UCAs consist of microbubbles with a 2-5 micron diameter capable of transpulmonary passage

Specifications and Mechanism

- Bubble of such small size is unstable in an aqueous system
- So it must be encapsulated by a stabilizing shell to achieve long lasting persistence
- A microbubble exposed to an ultrasound wave alternately compresses under the positive pressure and expands under the negative pressure. Thus producing harmonic waves

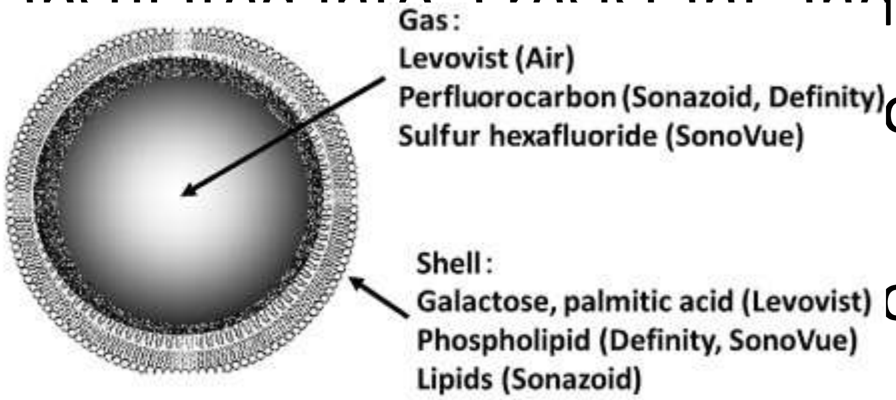
Mechanical index?

- The MI of ... ve pressure ... root of the frequ...
- 3 respons... obubble
  1. Scatt...
  2. Harm...
  3. Bubb...
- Which M...



Classes of UCA

- In the last few years, a new class of more stabilized and longer lasting UCAs has been manufactured;
- These UCAs use a heavy gas (perfluorocarbon) with a lower blood solubility that is enc … flexible lipid shell.
- These properties m … oustic power, avoiding the destru …
- They last a longer p … ous real-time assessment



Properties

- Intravenous bolus injection
- Pure intravascular distribution with no extravasation, unlike contrast agents for CT or MRI.
- Gases are not metabolized in the human body, and several minutes after their administration, they are eliminated by the lungs in exhaled air.
- The stabilizing shells are filtered by the kidney and eliminated by the liver.

Safety?

- Excellent safety profile
- They have no specific renal, cerebral or liver toxicity
- Their embolic potential is of no clinical significance

How to form image

- Used primaril
- Prone to moti rgan movements
- Use of THI wit artifacts

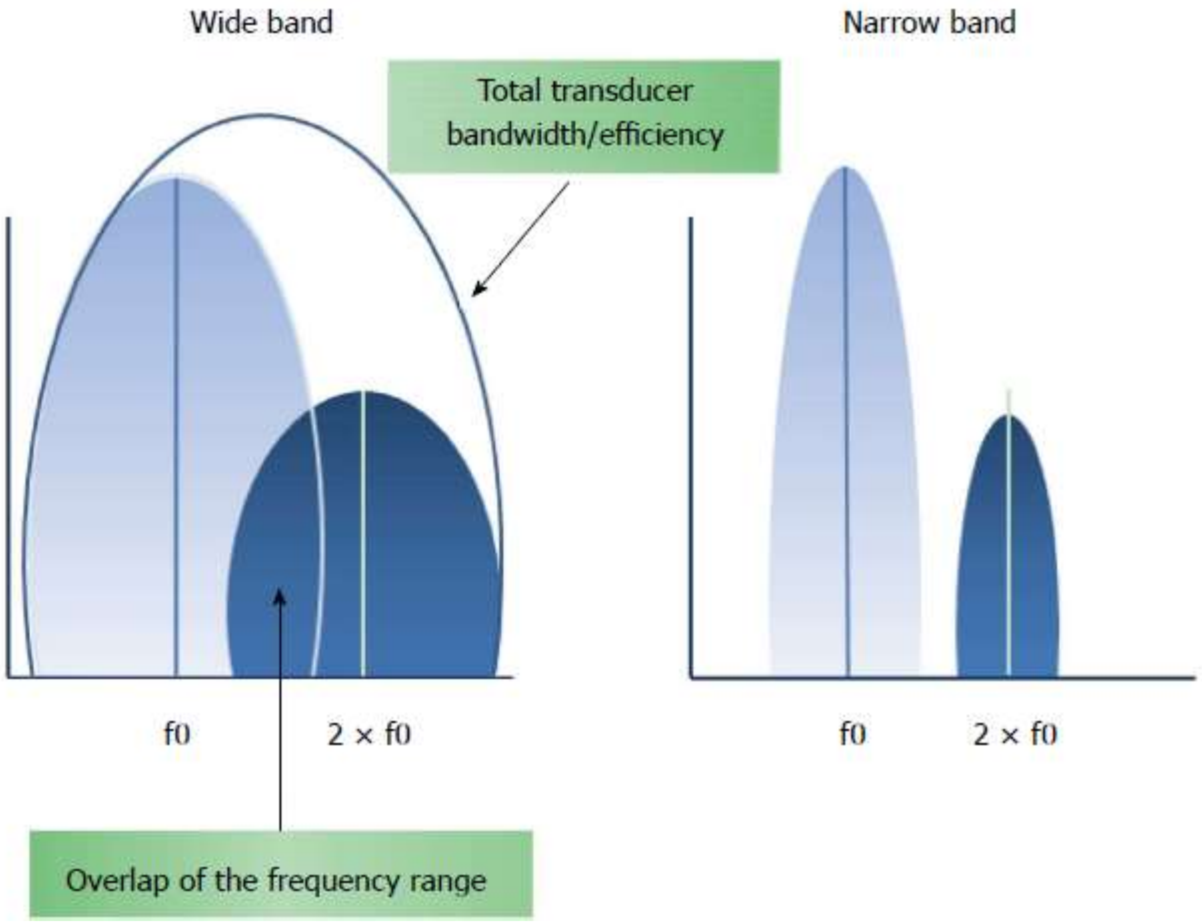


Image formation

- The harmonic signal is separated from the fundamental one by sending two trains of pulses out of phase with each other
- Filter is not used

Steps to perform CHUS

- 16-18 G IV Cannula must be employed.
- A three-way should be connected to the syringe with the contrast in line with the catheter, and an additional syringe should contain a saline solution at an angle of 90º.
- The contrast must be administered slowly and followed by a saline flush to avoid microbubble persistence in the vein

Continue…

- Examine the organ of interest in B mode first
- A relatively lower MI (0.25-0.30) is suitable for lesions located near the transducer (2 cm or less)
- Higher MI (0.35-0.40) may be needed to explore targets farther away from the transducer (1.5-3 cm).
- 10-20 s to observe the contrast agent’s arrival, after which the arterial phase starts.
- Arterial phase lasts approximately 30-45 s, during which time the enhancement increases progressively

In endoscopic USGs

- Low MI CEUS requires presence of harmonic imaging techniques and software which is not routinely present in endoscopic or endobronchial USG
- Whereas high MI CEUS requires presence of high intensity or acoustic power just like that is present in Doppler imaging
- Hence easier to used High MI CEUS

Availibility

- In Europe and Asia, the most commonly used UCA is SonoVue.
- 2,500 Rupees per Vial
- In patients with cardiac and/or pulmonary disease, the arrival time of pulmonary arterial supply may be longer than in cardiovascularly healthy subjects.

Benefits

- Differentiation of malignant from normal or inflammatory lymph nodes by displaying the macrovessel architecture.
- Normal lymph nodes generally show hilar-predominant normal vascularity.
- In benign lymph nodes, contrast enhancement within the cortex is homogeneous. Inflammatory lymph nodes are typically more vascularized without changes of the predominant hilar vessel architecture.
- In contrast, metastatic lymph nodes present peripheral or mixed vascularity with loss of the hilar-type vascularization

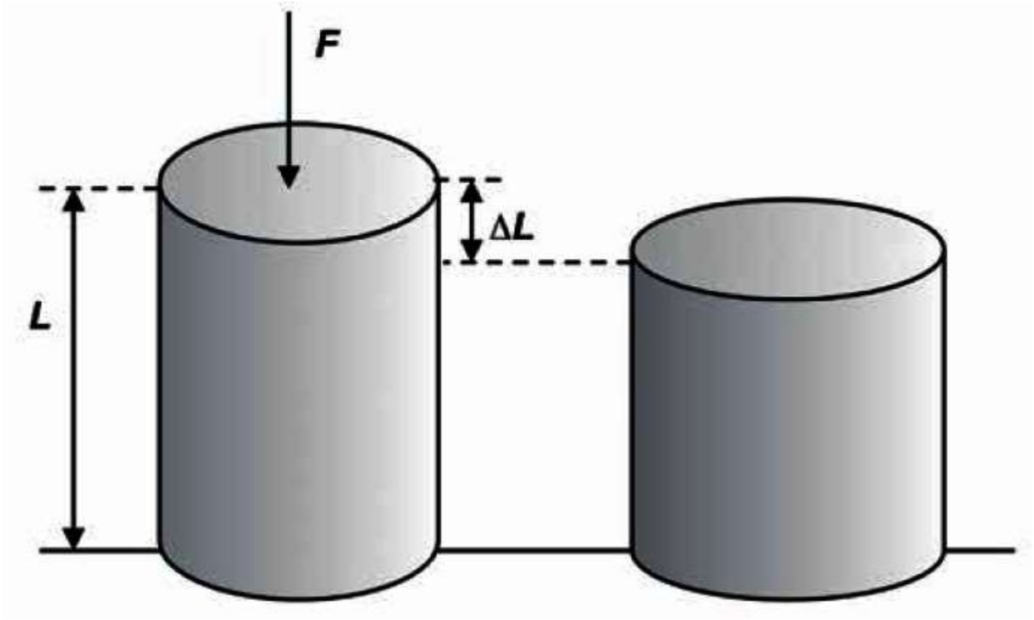
Alverez et al World J Gastroenterol 2014 Nov 14;20(42):15549-63

Section 4. Elastography

Basic concepts of elasticity

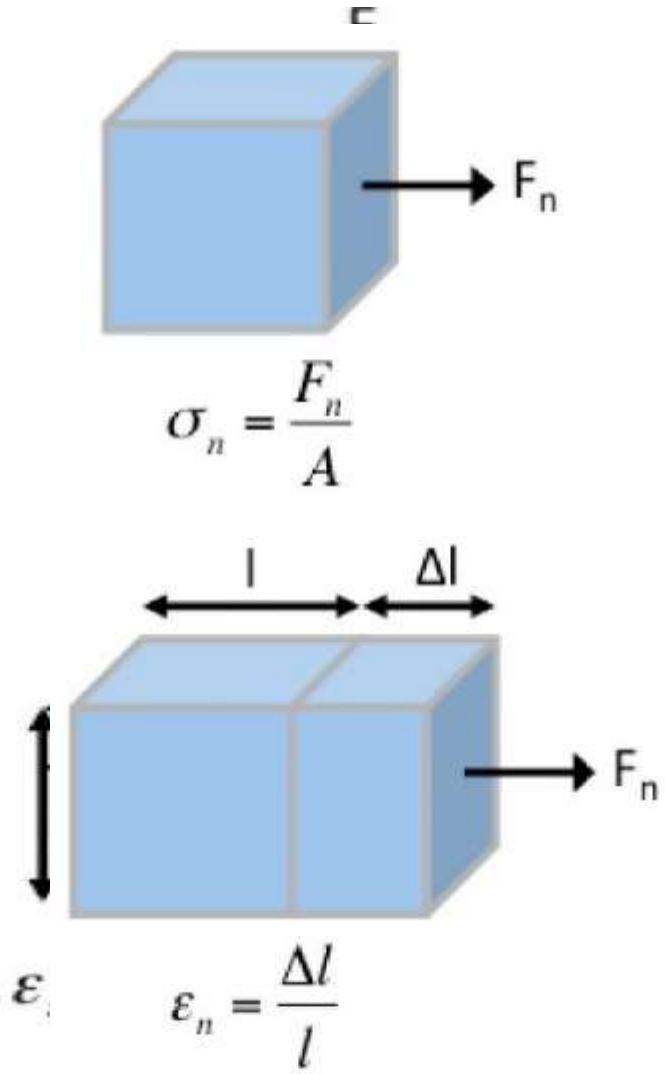
- Solids resist changes both in shape and volume
- Strain (ε): a change in the shape of the material under external force F

ΔL/L



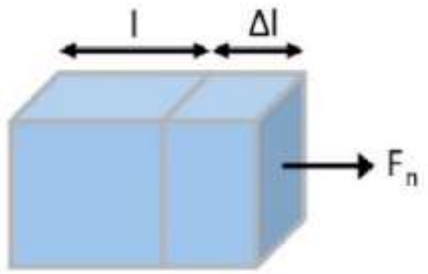
Terminologies

- Stress: force applied per unit area of the surfac
  (σ= F/A)
- This all was for longitudinal stress
- Now what if the stress in applied in tangential r
- In this case shear modulus will be the measure
  elasticity



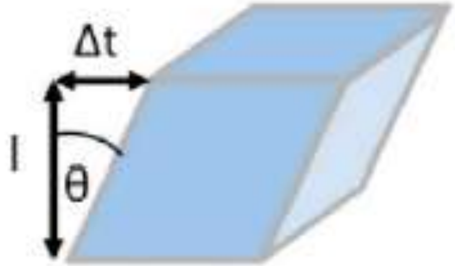
Measures of elasticity

- Shear modulus will be ***G = σ/ ε*** (Tangential stress)
- Young’s Modulus will be ***E= σ/ ε*** (Longitudinal stress)
- Bulk Modulus will be ***K= σ/ ε*** (Circumferential stress)



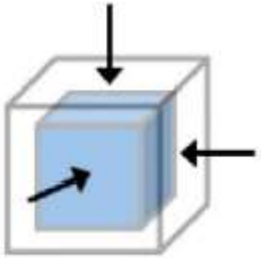
$$\varepsilon_n = \frac{\Delta l}{l}$$

$$Young's\ Modulus = E = \frac{\sigma_n}{\varepsilon_n}$$



$$\varepsilon_s = \frac{\Delta s}{l} = \theta(rad)$$

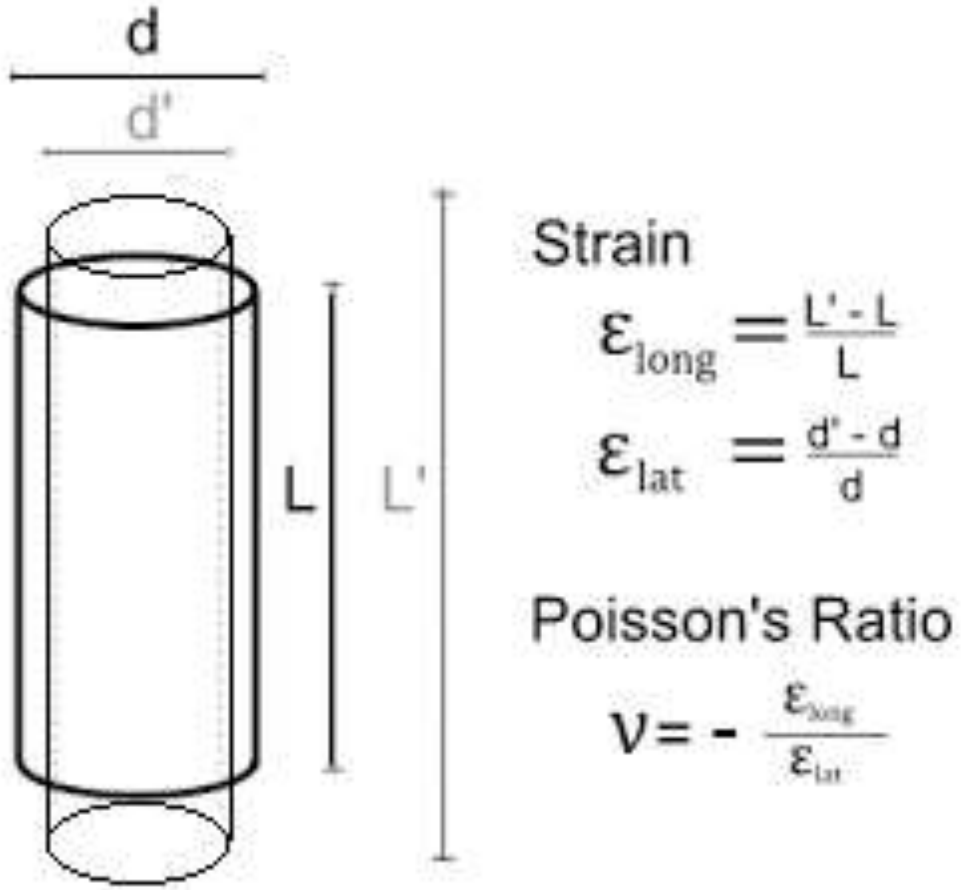
$$Shear\ Modulus = G = \frac{\sigma_s}{\varepsilon_s}$$



$$\varepsilon_B = \frac{-\Delta V}{V}$$

$$Bulk\ Modulus = K = \frac{\sigma_b}{\varepsilon_b}$$

Poisson's ratio



Why do we need it?

- For biological tissues, Poisson's ratio is usually between 0.490 and 0.499, which means that
- tissue is almost incompressible (for an incompressible liquid Poisson's ratio $\gamma = 0.5$).

What to measure?

- Shear waves speed : Shear waves have particle motion perpendicular to the direction of wave propagation
- Related to shear Modulus by the following equation

$$C_s = \sqrt{G/\rho}$$

- Young's Modulus

$$E = 2(v + 1)G$$

- v is poisons ratio which is taken as 0.5

$$E = 3G$$

Who decides what to measure?

- Young's modulus *E*, shear modulus *G*, and Shear wave speed C_s are related
- Important to know because Vendors use them to report elasticity individually
- A recent consensus advocates reporting results as shear wave speed C_s in m/s as part of a standardized approach

Sigrist et al Theranostics 2017; 7(5): 1303–1329.

Ultrasound elastography techniques

1. Strain Imaging
    i. Strain elastography
    ii. ARFI strain imaging
2. Shear Wave imaging

Strain Elastography

- Tissue displacement is measured in the same direction to that of stress applied.
- There are two approaches to apply this stress
    1. Manual Compression (preferred for superficial organs like liver)
    2. Internal physiological motion like respiration and Heart beat
- Tissue displacement is than detected and measured.
- To detect the tissue displacement the following signals are used like radiofrequency echo correlation based tracking, Doppler processing or a combination

Examples of strain imaging

- Young's modulus is derived from the stress applied and strain developed
- ***Strain Ratio*** is the ratio of strain measured in adjacent (usually normal) reference tissue region of interest (ROI) to strain measured in a target lesion ROI.
- A strain ratio >1 indicates that the target lesion compresses less than the normal reference tissue, indicating greater stiffness

Acoustic radiation force impulse (ARFI) strain imaging

- Instead of using an unquantified manual stress, high intensity acoustic pushing pulse is used to displace tissue
- Tissue displacement in the region of interest is than measured just like in strain elastography
- This technique is used by Siemens Virtual Touch^{TM} imaging

Shear wave imaging

- It differs from stress imaging in two ways
  - Stress applied is dynamic stress
  - The variable measured is not the tissue displacement but shear waves
  - Shear waves can be measure both in perpendicular and in parallel direction
- As the shear waves are measured instead of tissue displacement, even compression can be measured instead of displacement.

Three approaches of SWI

1. One Dimensional transient elastography: eg Fibroscan
2. Point shear wave elastography: AFRI is used, can be used with B mode USG
3. Two Dimensional shear wave elastography: Multiple foci of impulses are used there by generating more ROI.

Advantage of this 2D SWI is real time visualization of a color quantitative elastogram superimposed on a B mode image

Use of Elastography in endoscopic procedures

- Currently only Strain imaging technique has been available for endoscopic sono-elastography
- Strain elastography (SE) is a qualitative method based on tissues response to an externally or internally generated force
- With SE, the compression-induced tissues deformations within a region of interest (ROI) are comparatively assessed.
- The resultant strains are displayed as transparent colors overlaid on the B-Mode image, just like for Doppler ultrasound.

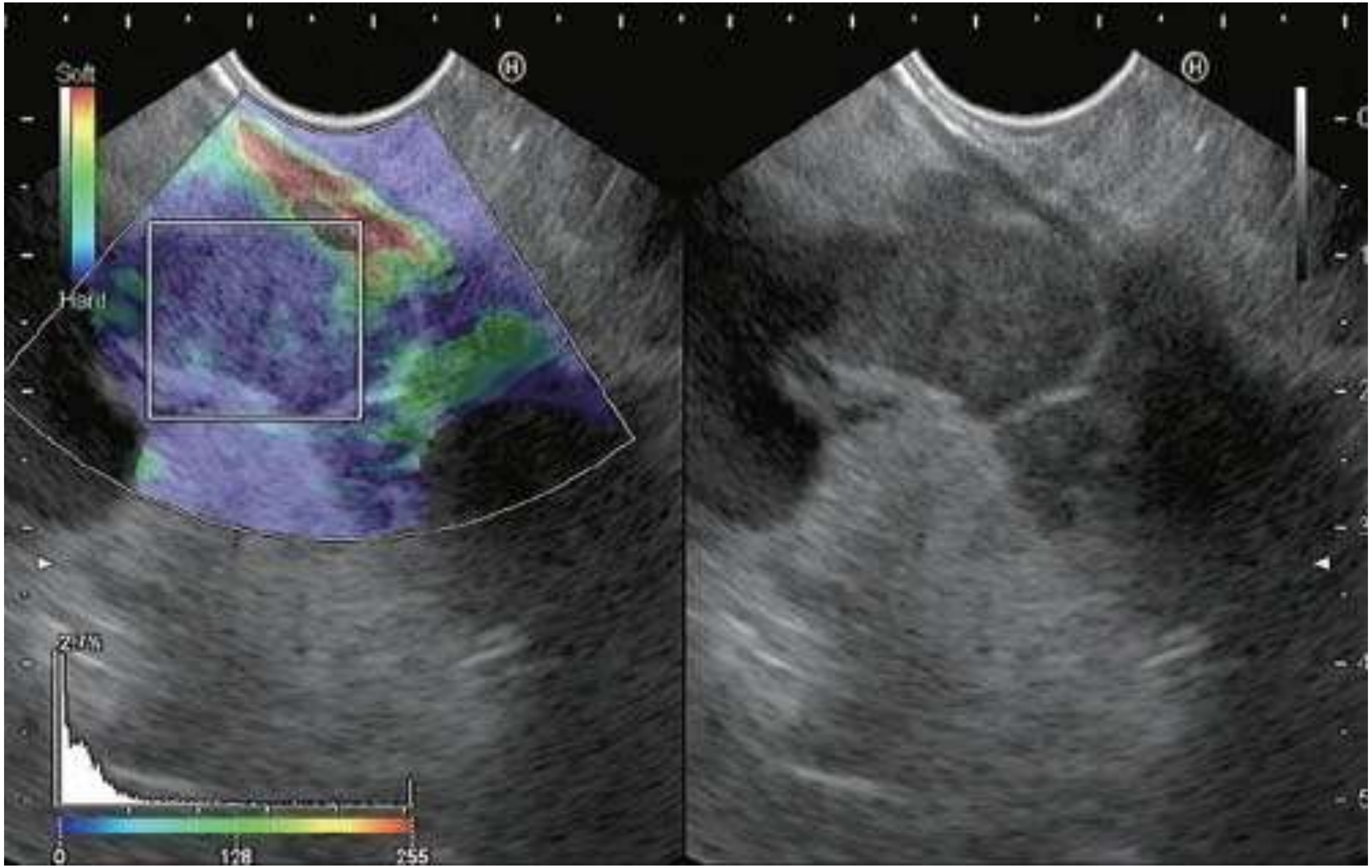
Quantification

- Hue Histogram (Mean)
- Strain Ratio
- Gray Scale
- Stiff Area ratio

Hue Histogram

- Hue histogram is a graphical representation of the color distribution in a selected image field.
- Based on the qualitative EUS elastography data for a manually selected ROI
- X-axis represents the elasticity from 0 (softest) to 255 (hardest) or vice versa.
- Y-axis represents the number of pixels in each elasticity level in the ROI.
- The mean value of the histogram corresponds to the global hardness or elasticity of the lesion

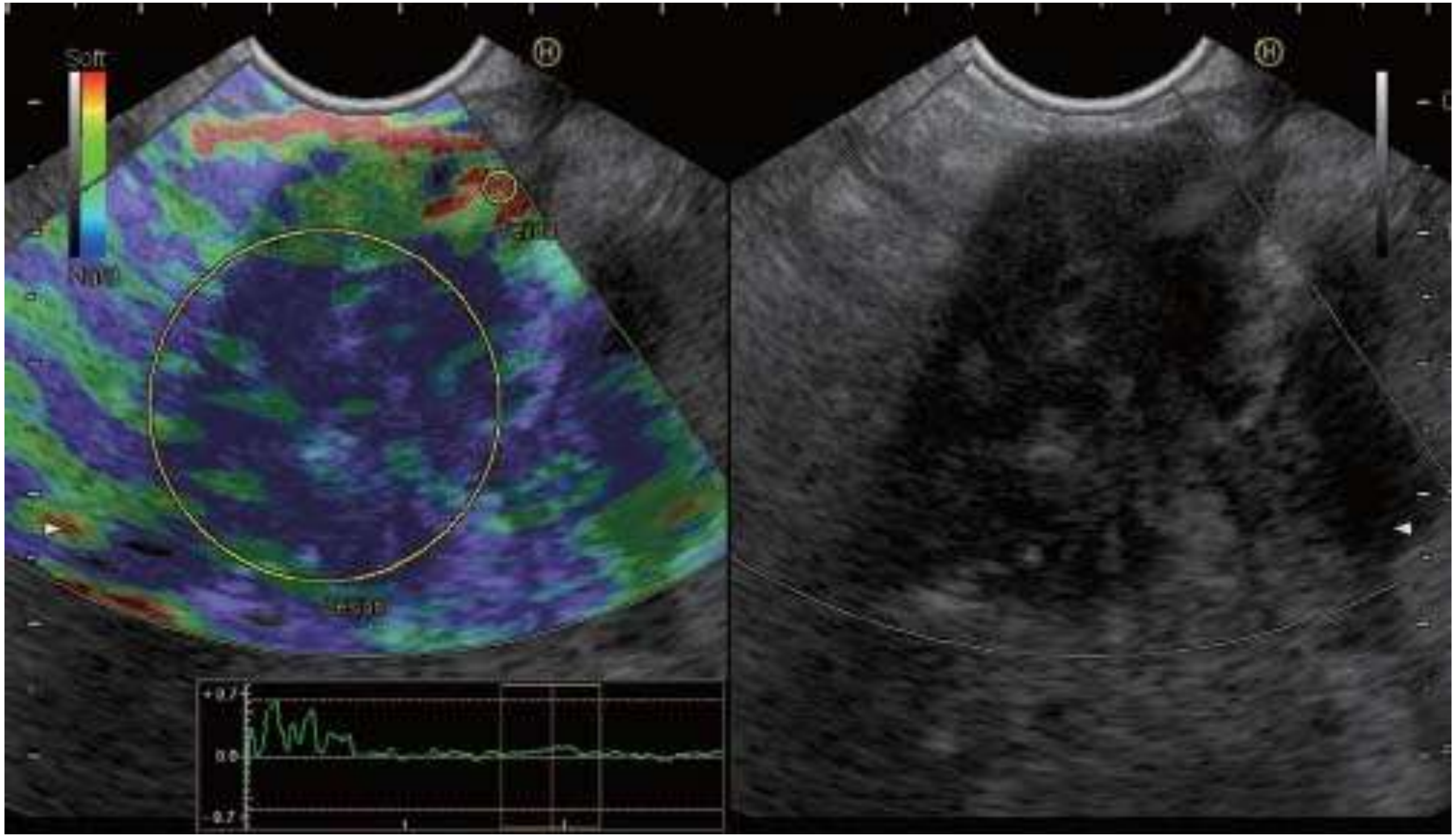
Example



Strain Ratio

- Two different areas (A and B) are selected for quantitative analysis.
- Area A is a represents ROI (with the lesion).
- Area B refers to a soft normal reference area outside the ROI.
- Strain ratio: Is the Ratio of Strains developed in Area B divided by that of area A
- As choice of area B is subjective hence three different measurements are taken and mean is reported

Example

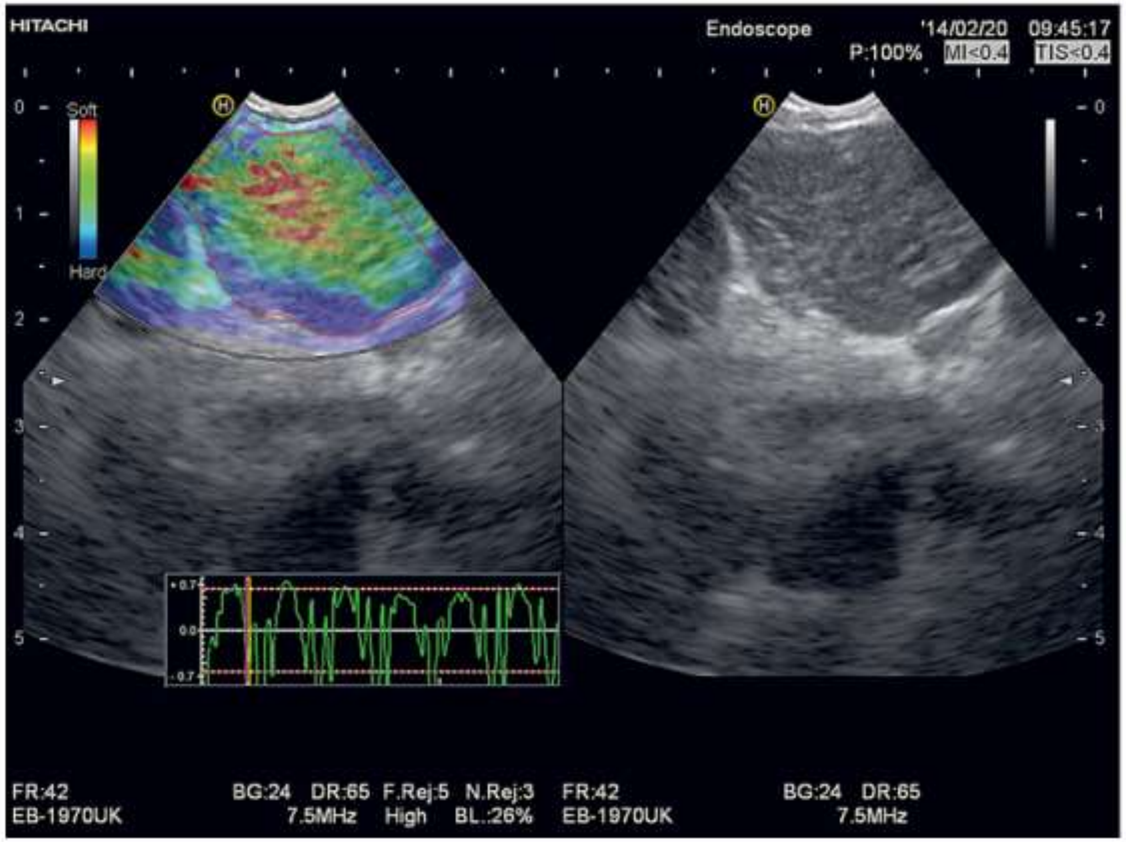


Gray scale

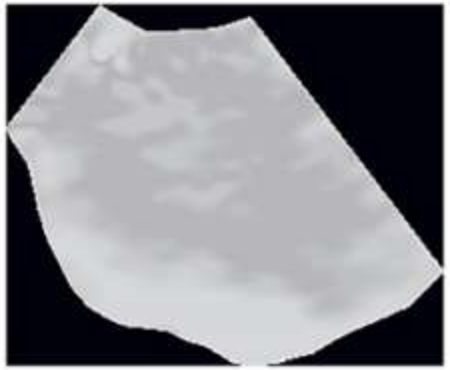
- Basically transforms color image to black and white
- Region of interest (ROI) is set on a double screen display.
- Pixel-by-pixel subtraction of the B-mode gray image from the color elasticity image is done
- The matrix of red, green, and blue values obtained from subtraction was transformed into a matrix of gray tone

Example

EBUS elastography



Transformed Gray Image



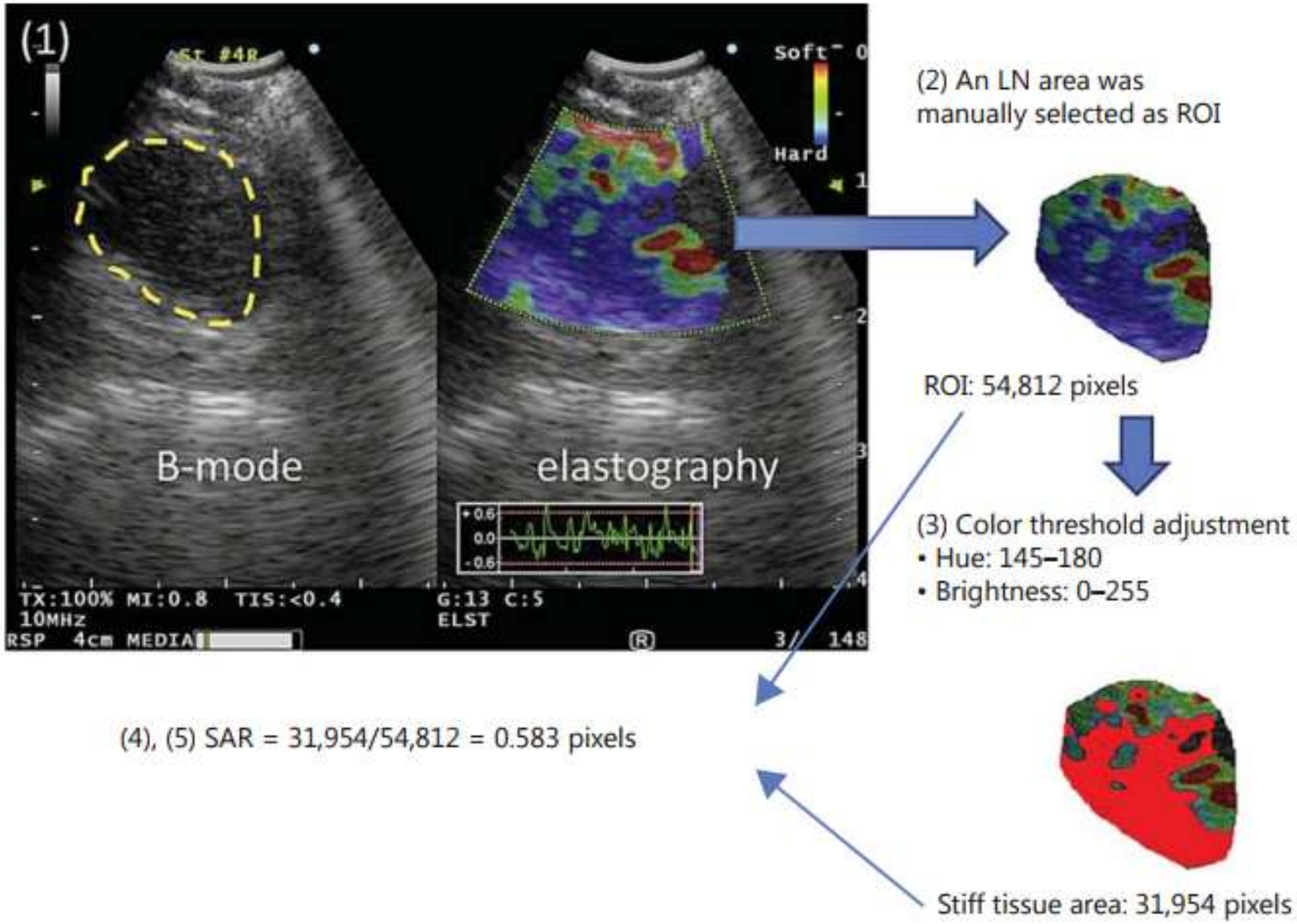
Mean Gray Value

186.8661

Stiff Area Ratio

- Defined as stiff area (blue color pixel area) per LN area (ROI) on the elastography image.
- The LN area (ROI) is selected to cover the entire targeted LN area based on the B-mode image
- Steps:
  1. A binary image was created from the raw image
  2. LN area was manually selected as the ROI
  3. Stiffer tissue area that is visualized as a colored pixel area was determined within a certain threshold level
  4. The ImageJ measure function is used to determine stiffer tissue area

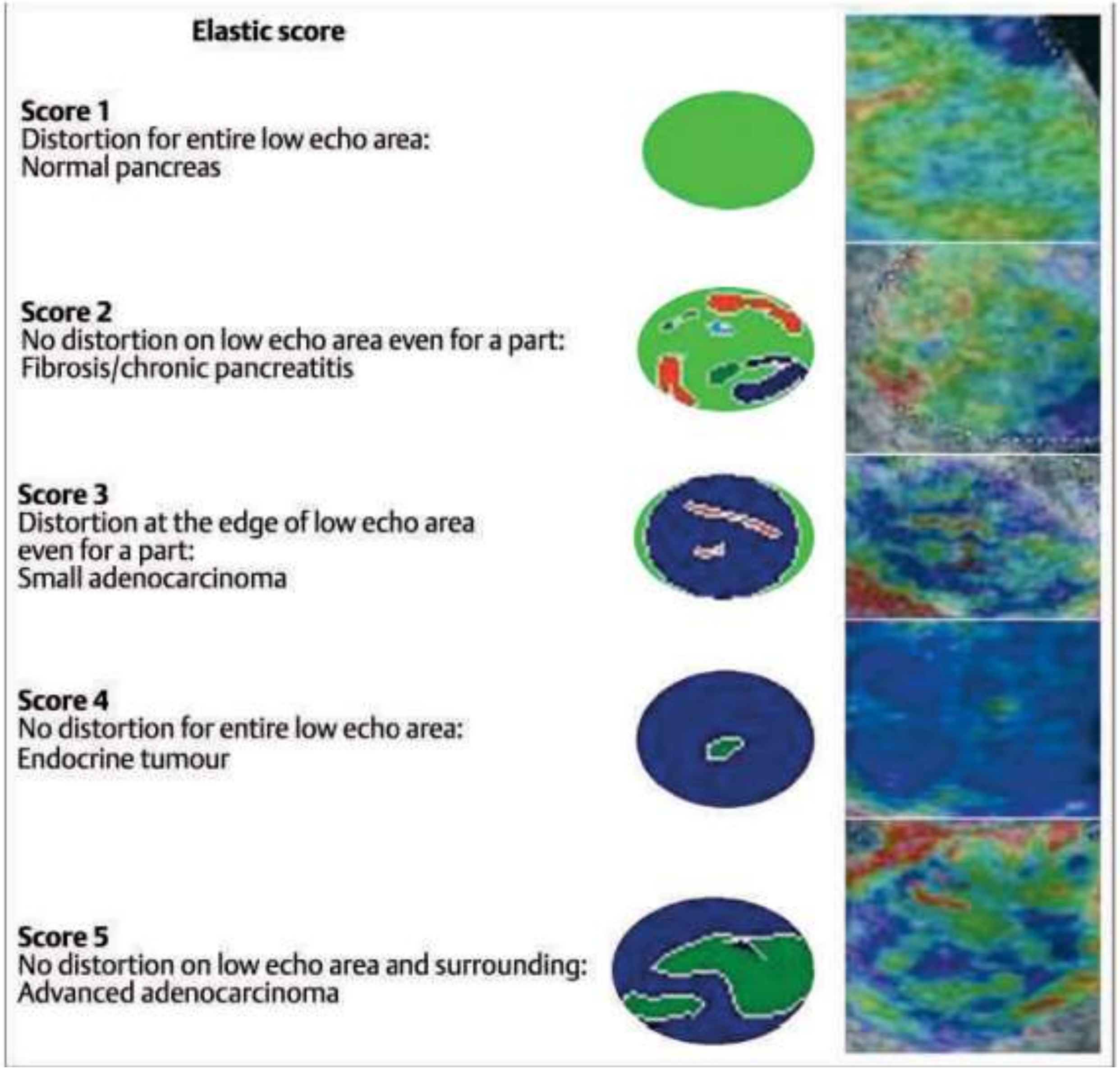
Example


(1)
Soft
Hard
B-mode
elastography
TX:100% MI:0.8 TIS:<0.4
10MHz
RSP 4cm MEDIA
G:13 C:5
ELST
(2) An LN area was manually selected as ROI
ROI: 54,812 pixels
(3) Color threshold adjustment
• Hue: 145–180
• Brightness: 0–255
(4), (5) SAR = 31,954/54,812 = 0.583 pixels
Stiff tissue area: 31,954 pixels

Approaches for Qualitative grading

- Different authors have tried to decode the colors in different grades
- Examples

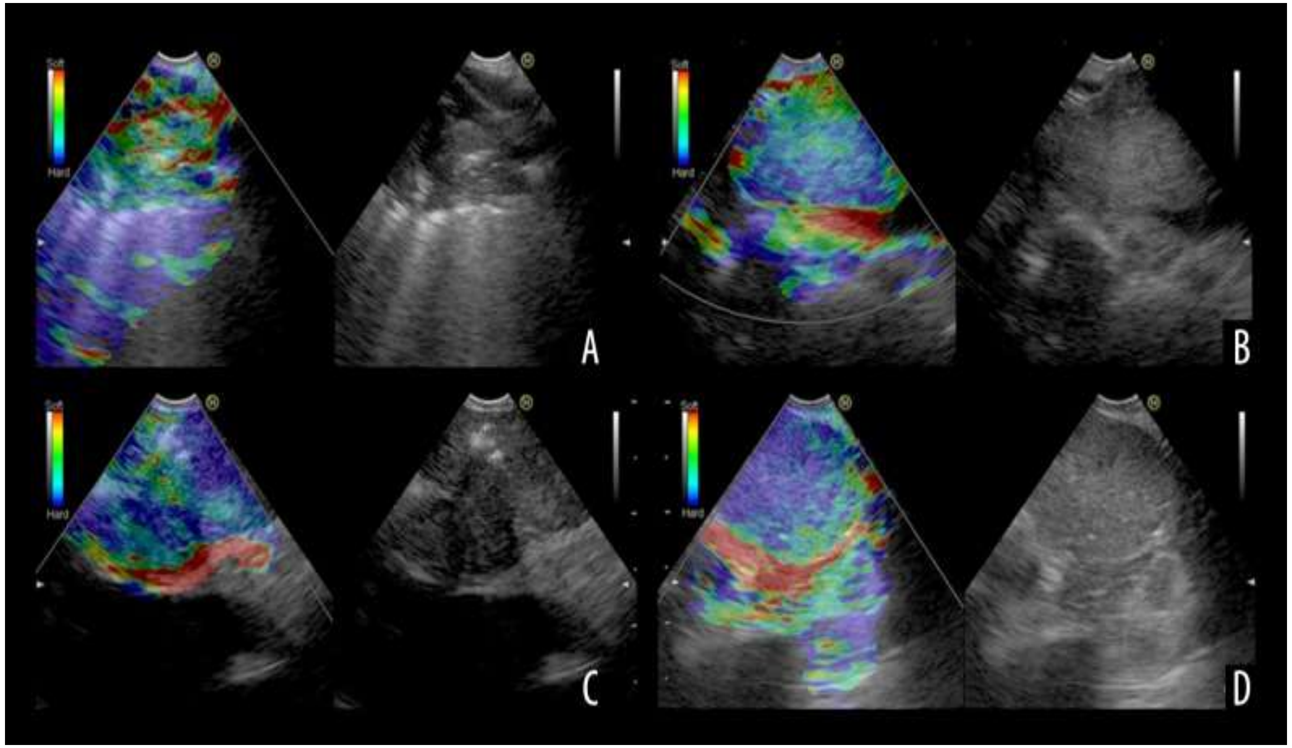
Giovannini et al



Giovannini et al Endoscopy. 2006 Apr;38(4):344-8.

Furukawa et al

- 1 point when over 80% of the section was green and yellow/red
- 2 points when over 50% but less than 80% of the section was green and yellow/red
- 3 points when over 50% but less than 80% of the section was blue
- 4 points when over 80% of the section was blue



Furukawa et al Nihon Jibiinkoka Gakkai Kaiho. 2007 Jul;110(7):503-5.

Sun et al

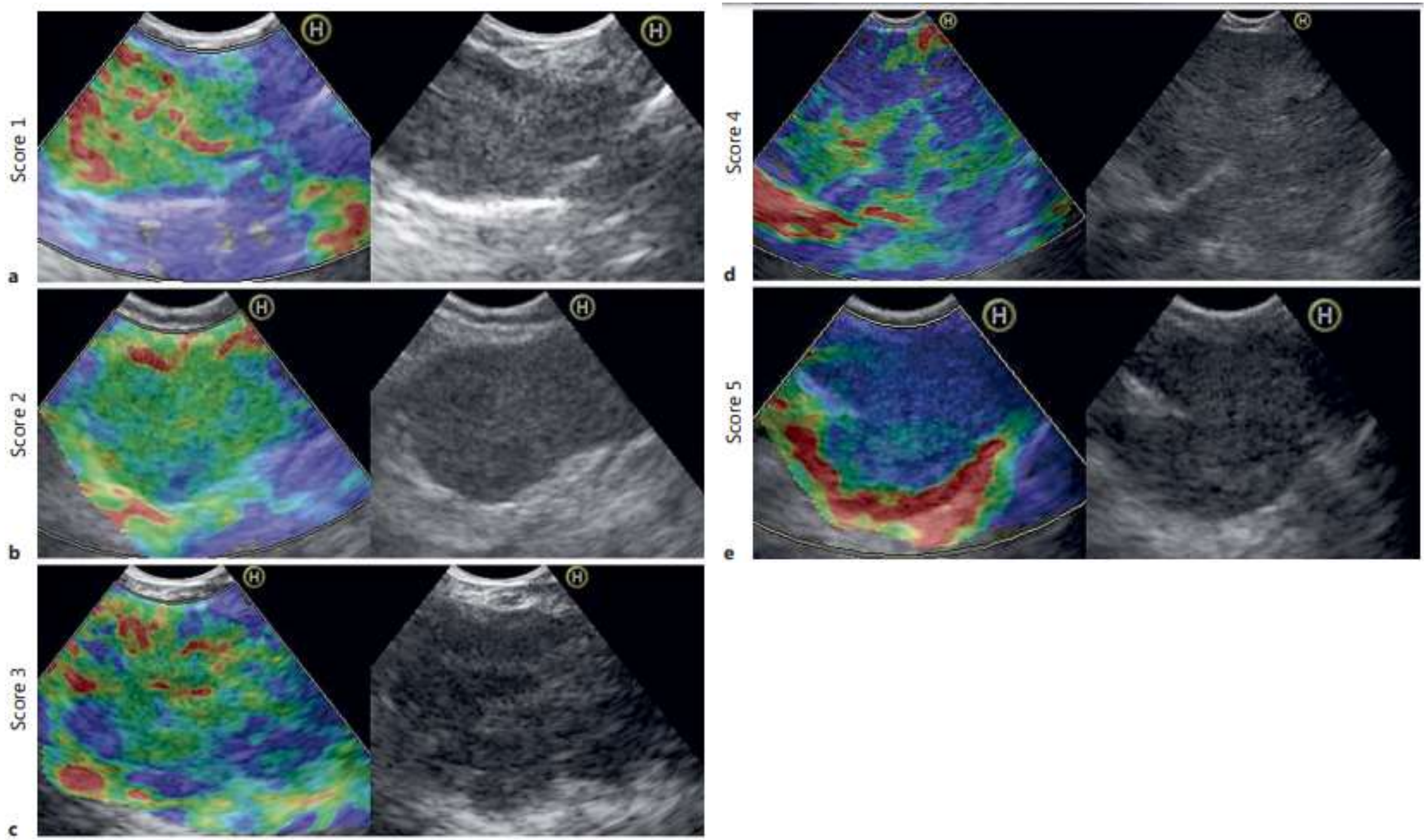
A) Score 1 (scattered soft, mixed green-yellow-red).

B) Score 2 (homogeneous soft, predominantly green).

C) Score 3 (intermediate, mixed blue-greenyellow-red).

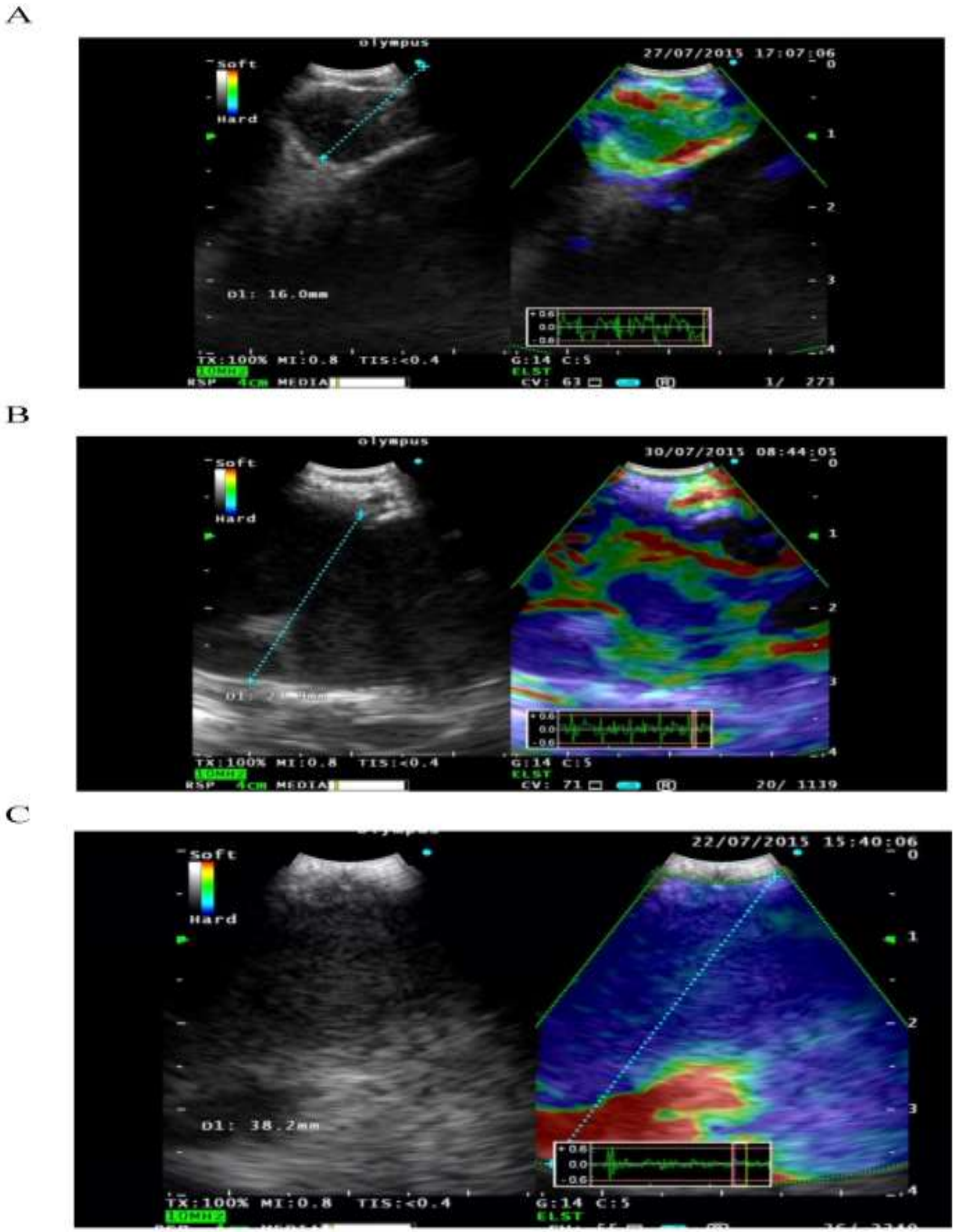
D) Score 4 (scattered hard, mixed blue-green).

E) Score 5 (homogeneous hard, predominantly blue).



Sun et al Respiration. 2017;93(5):327-338

Gu et al



Gu et al Oncotarget. 2017 Oct 24; 8(51): 89194–89202.

Use of elastography in EUS

- For diagnosis and sampling in Pancreatic CA
- Chronic non calcified pancreatitis diagnosis
- Cystic adenocarcinomas
- Neuroendocrine tumors
- CBD stones

Section 5. Elastography in EBUS

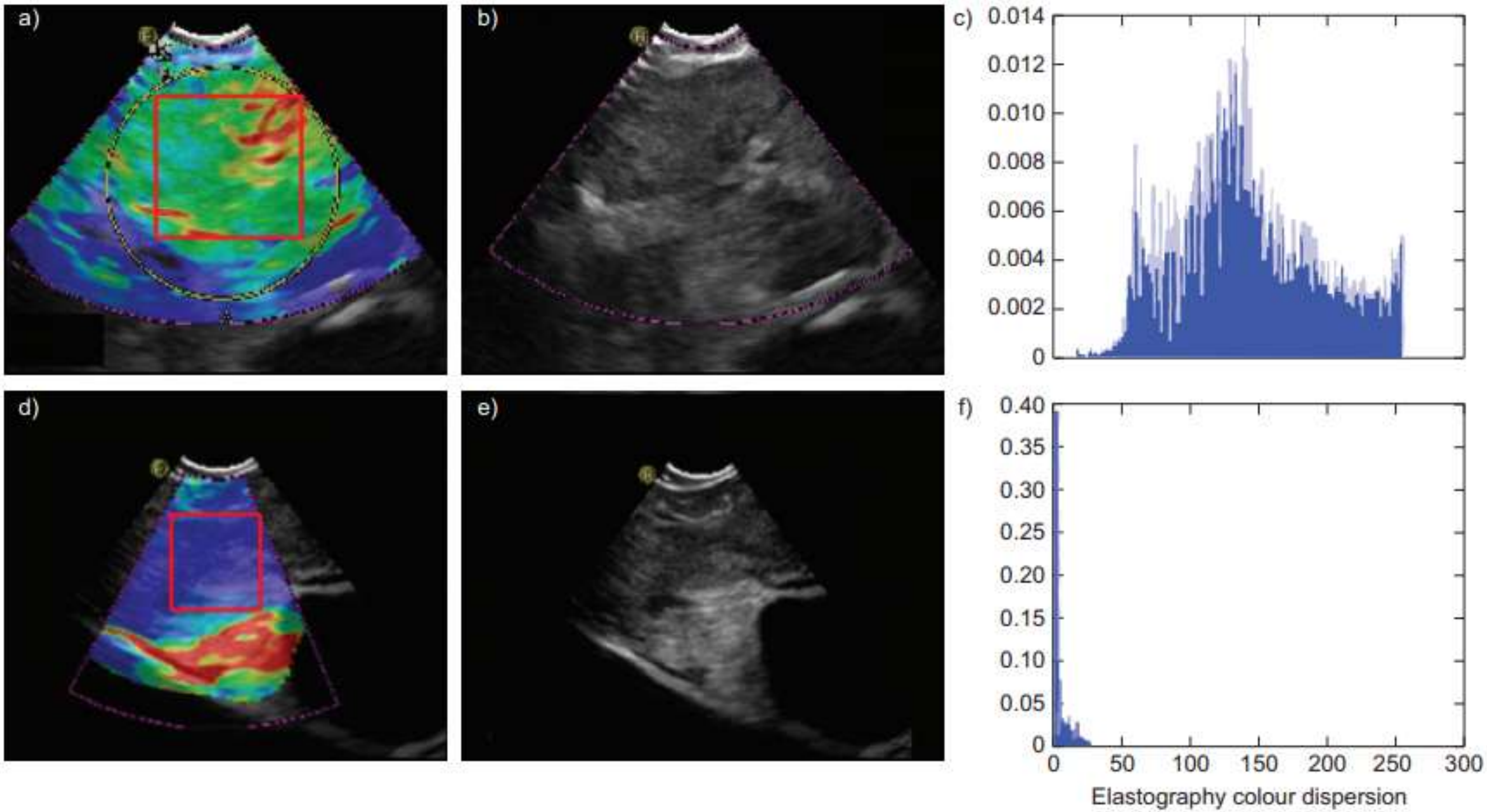
Performing Elastography with EBUS…

- Elastography relies on the movement and compression deformation of observed tissues.
- Breathing exercises and vascular pulsations often had a less pronounced effect on compression deformation of lung lesions but a more pronounced effect on mediastinal lymph nodes
- Since a high-frequency transducer is used in EBUS elastography, the depth of penetration is limited
- Due to the existence of breathing exercises and vascular pulsations, it is impossible to obtain completely identical elastic recordings. Hence multiple imaging with mean values should be used.

First Feasibility study

- Methods: 10 patients and 13 LN
- All patients underwent EBUS, TBNA, Elastography and calculation of Mean Hue value along with color coding was also done
- Results: TBNA from 5 LN which had > 80% blue color were all malignant
- Rest 8 LN had blue color less than 71%. None of them were found to be malignant

Trosini et al Eur Respir J. 2013 Feb;41(2):477-9.



a)
b)
c)
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0
d)
e)
f)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0
0
50
100
150
200
250
300
Elastography colour dispersion

Literature search

- 21 relevant results with EBUS/Elastography/ Endobronchial USG
  - Review 4
  - Editorial 1
  - Chinese 2
  - Russian 1
  - Spanish 1
  - Correspondence 1 (AIIMS highlighting type 3 pattern in TB)
  - Reply 1

Analysis of studies comparing Color coding.

- 6 Studies
- 322 patients 519 Lymph Nodes analyzed
- Reporting of Elastography
  - 3 Grades: 4
  - 5 Grades: 2
- In the studies with 5 grades, grade 4 and 5 have been proposed to represent malignant lesions

Summary of the results of the qualitative studies

	True Positive	True Negative	False Positive	False negative
Izumo et al Jpn J Clin Oncol 2014 Oct;44(10):956-62	35	30	2	8
Gu et al Oncotarget. 2017 Jul 6;8(51):89194-89202	**42**	**37**	**7**	**47**
Huang et al J Cancer 2017; 8(10): 1843–1848.	27	41	4	6
He et al Med Sci Monit. 2017; 23: 3269–3275.	26	16	5	10
Korrungruang et al Respirology 2017 Jul;22(5):972-977.	95	18	6	1
Sun et al Respiration 2017;93(5):327-338	30	27	6	5
TOTAL	**255**	**169**	**30**	**77**

Final Result

	Elastography Positive	Elastography Negative
TBNA Positive	255	77
TBNA Negative	30	169

Diagnostic values

- Sensitivity: 76.81
- Specificity: 84.92
- Positive predictive value: 89.47
- Negative predictive value: 68.70

The odd one out…

- Single Centre Prospective study
- From 1 May 2015 and 31 May 2015: One month
- Exclusion criteria: Distant metastases, mediastinal tumor infiltration
- Intervention: EBUS, Elastography and Ultrasound and Doppler features were recorded, TBNA was done
- Three patterns of Elastography were recognized
- ROSE was done
- Elastography movies and TBNA smears were reported by blinded raters

Gu et al Oncotarget. 2017 Oct 24; 8(51): 89194–89202.

Results

- 133 lymph nodes in 60 patients
- 89 Malignant and 44 benign

	Malignant	Benign
Type 1	**0**	**13**
Type 2	**47**	**24**
Type 3	**42**	**7**

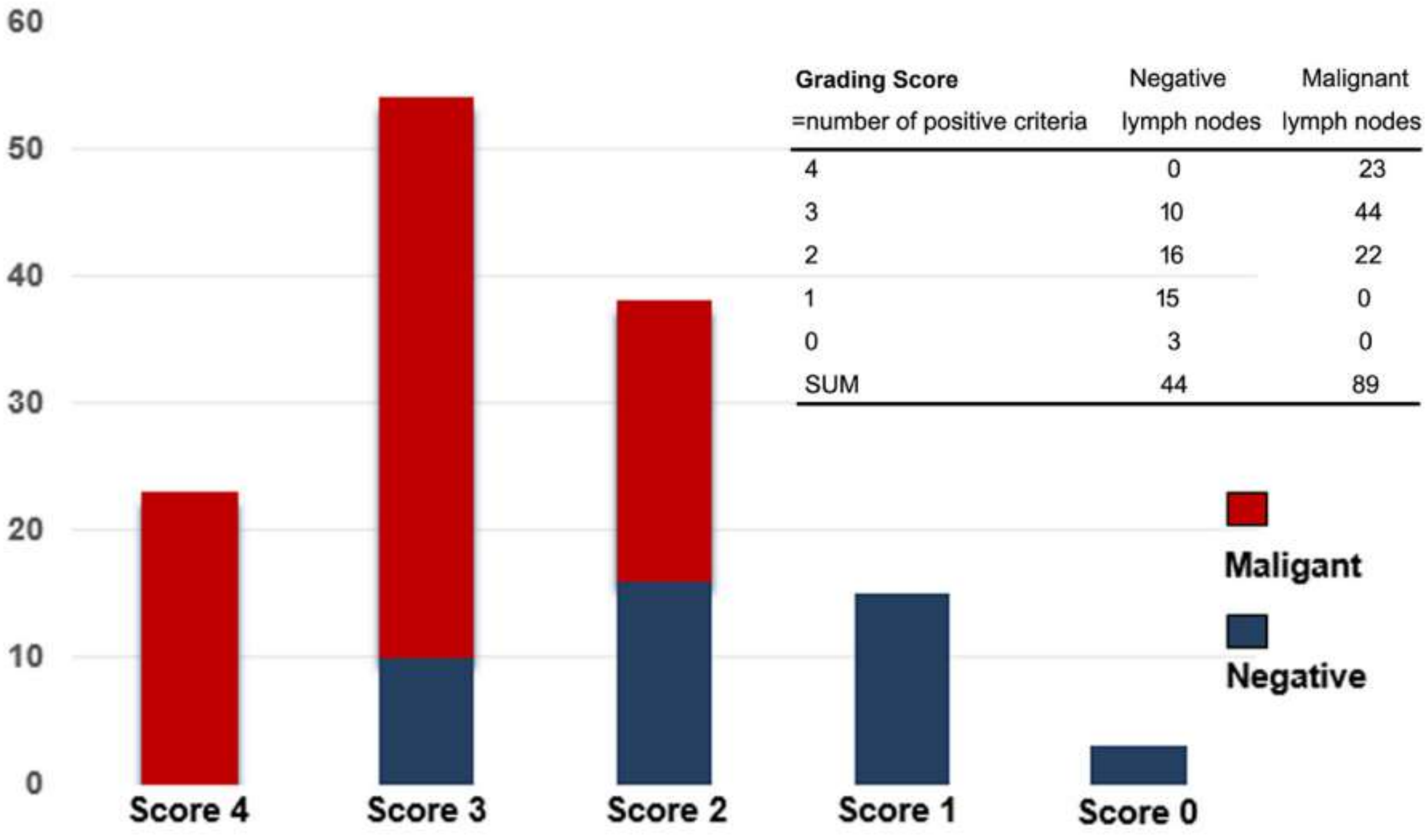
Gu et al Oncotarget. 2017 Oct 24; 8(51): 89194–89202.

Diagnostic efficacy of USG criteria in d/f malignant LN

Lymph node variate	AUC (95%CI)	Sensitivity (95%CI)	Specificity (95%CI)	PPV	NPV	Diagnosis accuracy	*P*
Short axis ≥10 mm	0.665 (0.579-0.745)	0.876 (0.808-0.944)	0.455 (0.307-0.602)	0.765	0.645	0.737	0.002
Round shape	0.603 (0.515-0.687)	0.798 (0.714-0.881)	0.409 (0.264-0.554)	0.732	0.500	0.669	0.017
Margin distinct	0.598 (0.509-0.682)	0.831 (0.754-0.909)	0.364 (0.221-0.506)	0.725	0.516	0.677	0.068
Echogenicity heterogeneity	0.711 (0.626-0.786)	0.831 (0.754-0.909)	0.591 (0.446-0.736)	0.804	0.634	0.752	<0.001
Coagulation necrosis sigh	0.572 (0.483-0.657)	0.326 (0.228-0.423)	0.818 (0.704-0.932)	0.784	0.375	0.489	0.177
CHS with central blood vessel	0.530 (0.442-0.617)	0.281 (0.188-0.374)	0.659 (0.519-0.799)	0.625	0.312	0.406	0.574
Elastography type							
3 versus 1	0.825 (0.707-0.910)	1.000 (0.916-1.000)	0.650 (0.408-0.846)	0.857	1.000	0.887	<0.001
2 versus 1	0.676 (0.565-0.774)	1.000 (0.925-1.000)	0.351 (0.202-0.525)	0.662	1.000	0.714	<0.001

Gu et al Oncotarget. 2017 Oct 24; 8(51): 89194–89202.

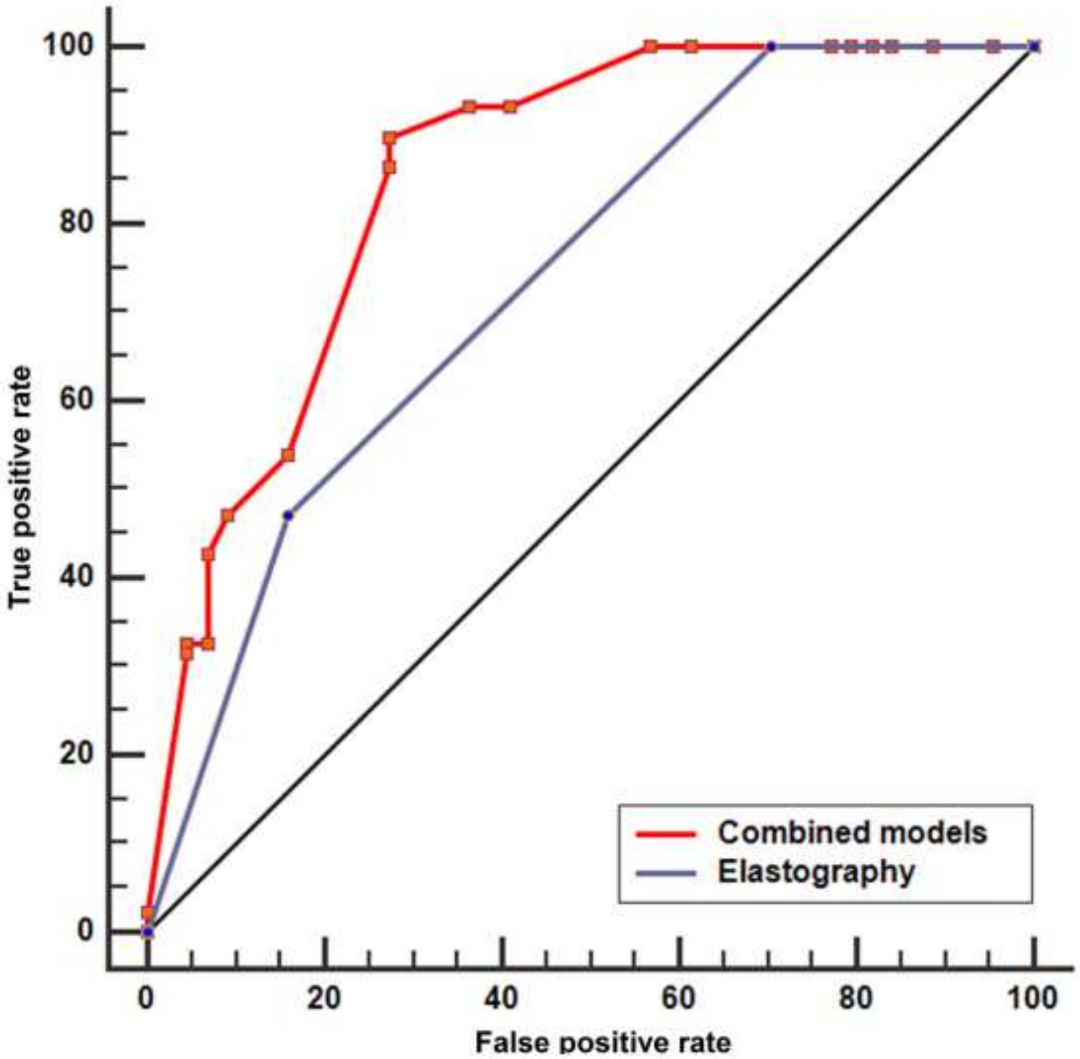
Combining multiple variables



Grading Score =number of positive criteria	Negative lymph nodes	Malignant lymph nodes
4	0	23
3	10	44
2	16	22
1	15	0
0	3	0
SUM	44	89

Gu et al Oncotarget. 2017 Oct 24; 8(51): 89194–89202.

ROC analysis for combined & elastography models



Other studies

	Variable used	N	Results	Cut off	Diagnostic Efficacy (Sn/Sp)
Mao et al Zhonghua Jie He He Hu Xi Za Zhi. 2017 Jun 12;40(6):431-434.	Stiff Area ratio Mean Hue Value	56 pts & 68 LN	SAR & MHV of benign and malignant lesions were significant between the two groups	SAR: 0.48 MHV: 126.28	SAR: 82.86/81.82 MVH: 85.71/75.76
Rozman et al Radiol Oncol. 2015 Nov 27;49(4):334-40	Strain ratio	33 pts & 80 LN	SR was significantly different in two groups	8	86.25/88.24
Nakajima et al Respiration. 2015;90(6):499-506.	Stiff area ratio	21 pts & 49 LN	SAR was significantly different in two groups	0.478	81/85
He et al Chin Med J (Engl). 2015 Oct 20;128(20):2720-5	Strain Ratio	30 pts & 68 LN	SR was significantly different in two groups	32.07	88.1/80.8
Sun et al Respiration. 2017;93(5):327-338	Mean gray Values	56 pts & 68 LN	MGV was **not** significantly different in two groups	--	--
Korrungruang et al Respirology. 2017 Jul;22(5):972-977.	Strain ratio	72 pts & 120 LN	SR was significantly higher in malignant group	2.5	92.3/93.2

Quantitative analytic studies: Summary

- In 6 studies: 4 variables have been used
- Strain ratio has been used most commonly but the diagnostic cut off that have been derived vary significantly
- Though analyzed only in two studies SAR had more reproducible cut off (0.478 and 0.48)
- Conclusion: more well refined studies are needed to provided a standardized cut off of an ideal variable

Elastography-EBUS Conclusion

- New innovative diagnostic tool
- Uses elasticity measurement in qualitative and quantitative manners
- Has been found to have significant correlation with malignant LAP
- Different variables and quantification methods have been studied
- Short comings: other causes of LN enlargement and their effect of elastography has not been studied
- Standardization of the procedure is still in evolving stages
- Future prospects: could help to sample the right area in a large LN
- Unlikely to replace TBNA for the diagnosis of malignancy

Section 6. Fine Flow

Fine flow/ eFlow/ H Flow/ B Flow

- Currently Doppler is the standard of care to differentiate the tisse from blood
- Conventional Doppler has several short comings like limited imaging angle and poor resolution for smaller vessels
- HFUI was introduced in 2006 for clinical application for solid organs
- Use of HFUI has been established in superficial organs like thyroid, breast and eyes

Principle

- High frequency transducers provide greater resolution for organs
- The short coming is that higher the frequency lesser will be the penetration
- Hence its use has been limited to superficial organs only

In Endobronchial USG

- Specifically has not been studied for endoscopic and endobronchial ultrasounds
- But provides a better image
- Currently PENTAX and HITACHI and Olympus provide this software in their equipment's
- Knows by different names in different vendors
- Uses high frequency (20 Hz) to form a dynamic image which shows even small vessels

Example

Benefits of Flow mapping technology

- Helps depict the finer vessels and their distribution
- Can be used to avoid vessels during sampling
- Dilution of the lymph nodal aspirate with blood can be decreases
- As mediastinal structures are in close proximity with probe, lack of depth screening should not be an issue

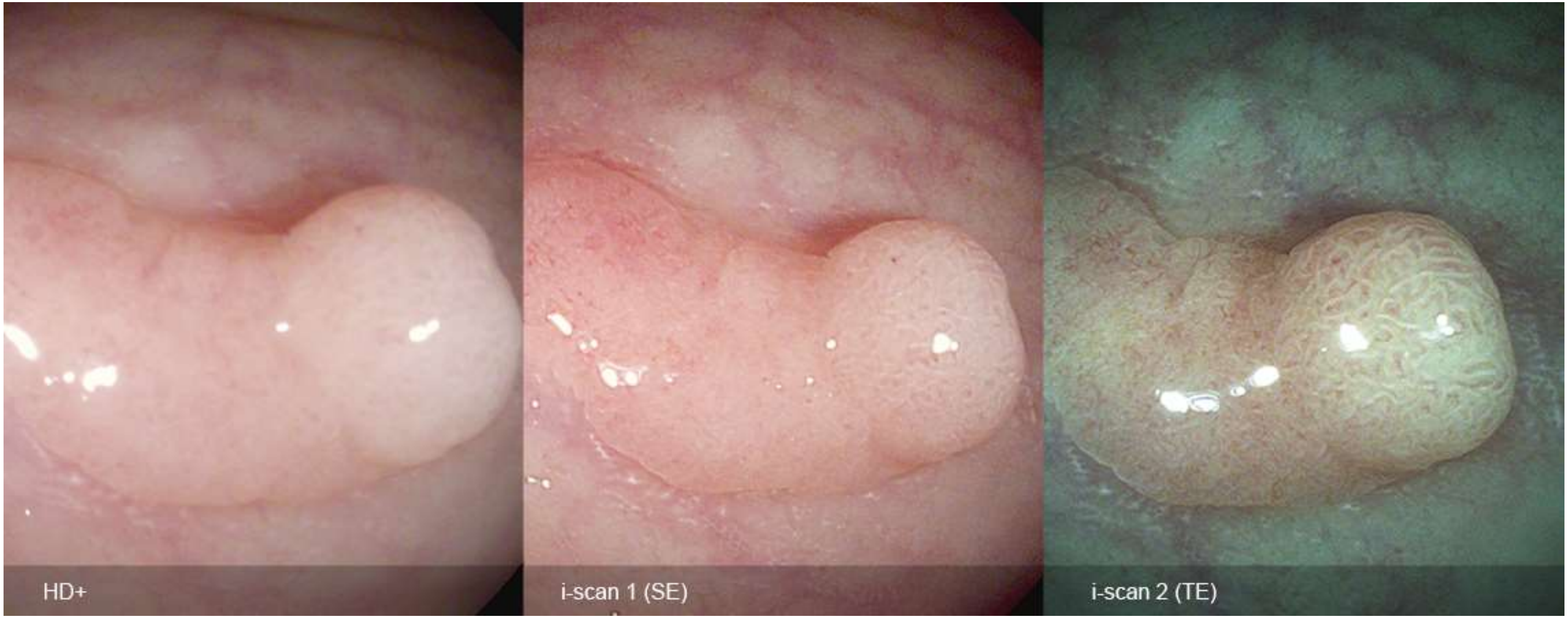
Short comings

- No data to suggest the benefit of fine flow directed sampling and B mode guided sampling
- Costly device
- Not available with Fijifilm.

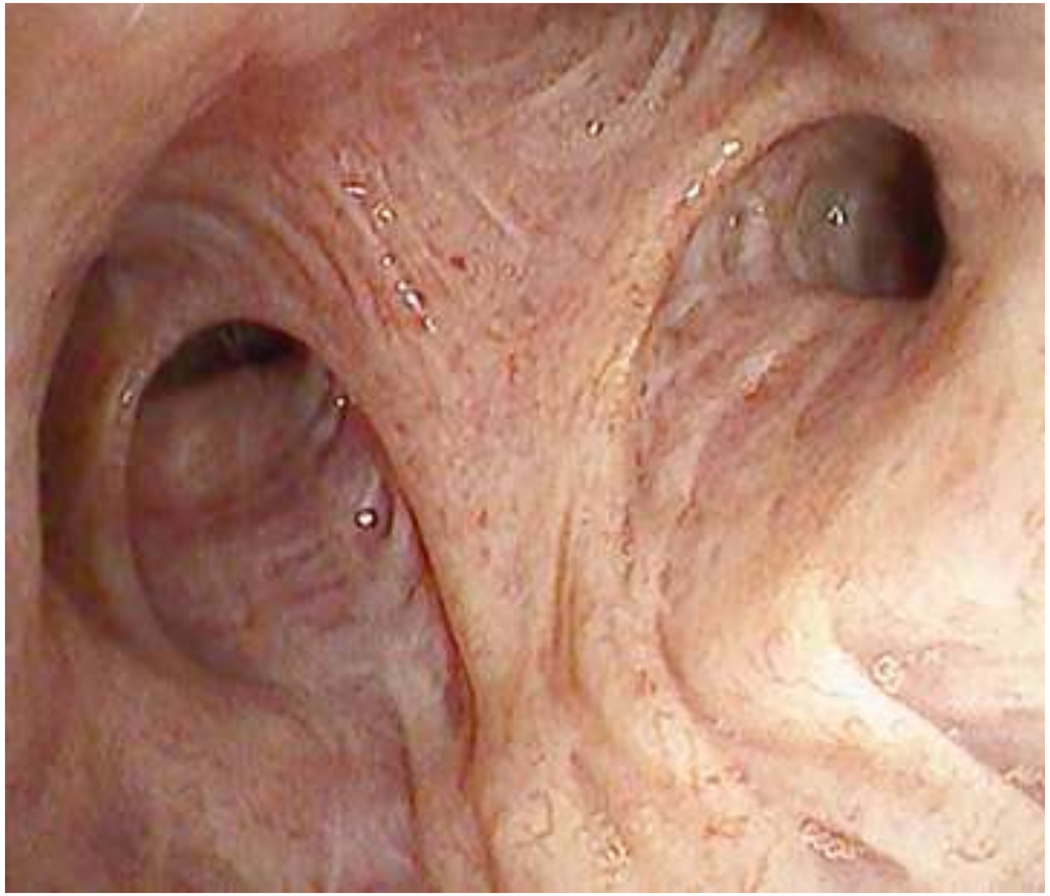
i-Scan

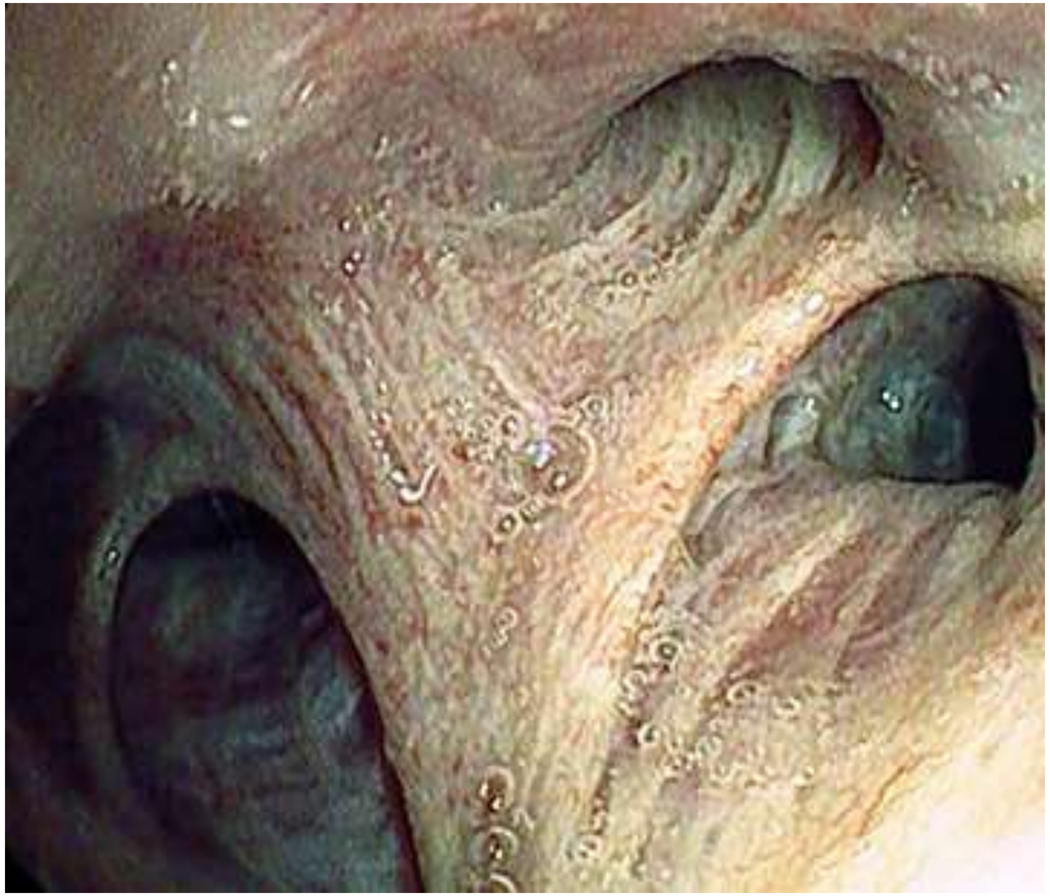
- Not related to EBUS
- Marketed by PENTAX with DEFINA systems
- Basically a digital image enhancement technology
- Provides high resolution images with real time interface
- Can even pick up epithelial lesion and guide better targets for smapling

Poly visualization in Colonoscopy with iScan



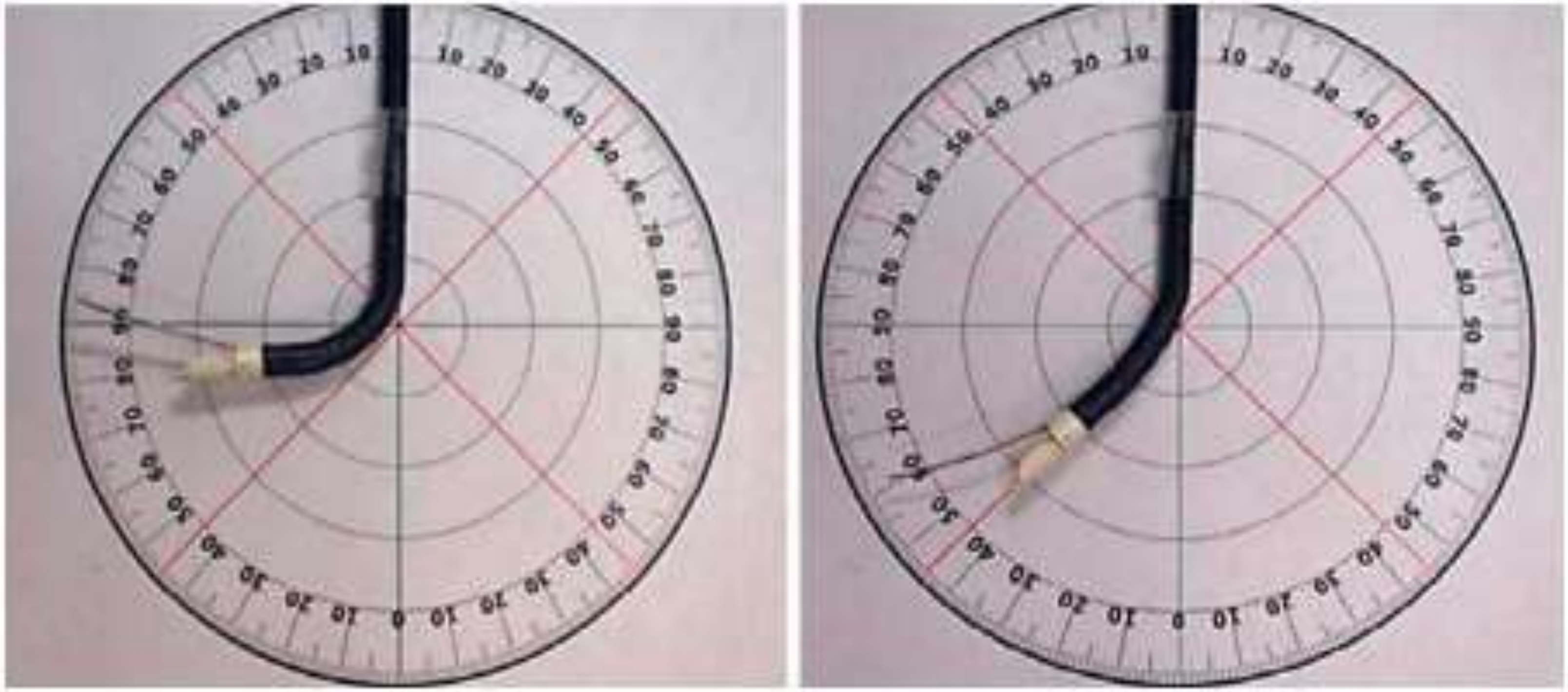
With iScan





New Needle: Flexible 19G

- Flex 19G TBNA needle (Flex 19G; Olympus Respiratory America)



Tyan et al Respiration. 2017;94(1):52-57.

Study

- 47 patients with mediastinal LAP were studied
- EBUS TBNA was done with 19G Flexi needle
- 9 different Endobronchoscopists were involved
- Results: Diagnosis was achieved in 89% patients
- Adequate tissue was obtained for mutation analysis in pts who had adenocarcinoma as final diagnosis
- Similar study by Trisoloini et al, showing 100% diagnosis eastbalishment in 13 pts who underwent EBUS=TBNA with 19 G needle

Trisolini et al Clin Respir J. 2017 Nov 4.
Tyan et al Respiration. 2017;94(1):52-57.

Section 7. Comparison btwn d/f vendors

Newer technologies available

- THI
- Elastography
- CE ultrasounds
- Fine flow

	PENTAX Medical EB19-J10U	EG-530UT2 (Fijifilm)	EBUS (BF-UC180F) Olympus
Elastography	✓	✗	✓
THI	✓	✗	✓
Contrast enhanced US	✗	✗	✓
Fine Flow	✓	✗	✓
Viewing angle	45°	40°	35°
Field of view	100°	140°	80°
Bending capacity L/R	✗	✓	✗
Forceps channel Diameter	2.2 mm	3.8mm	2.2 mm
Working length	600 mm	1,250 mm	600 mm
Scanning frequency	5-13 Hz	5- 14Hz	5-12 Hz