Echo for the Assessment of Acute Chest Pain

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- Chestpain is very common problem presenting to ER
- Broad differential
  - Includes life threatening conditions
- Echo can be used to rapidly an accurately arrive at a diagnosis
  - Point of care approach
  - Should be mastered by all trainees
  - Modern core of triage

- Chest pain ≠ coronary artery disease
  - Numerous other causes
  - Triage
  - Particularly the sick patient

Challenges include:

- Myocardial infarction
- Pulmonary embolism
- Aortic dissection
- Pericardial causes
- Mediastinal causes
- Musculoskeletal
- Biliary colic and oesophagitis

where, what & whom?

- Point of care devices are everywhere
- Embrace ultrasound as the modern stethoscope
- ER physicians “invading” the space
  - Justifiable need
  - Practicing clinical cardiologists need same/superior skill set
  - All trainees
  - All emergency cath patients ideally

The American Society of Echocardiography - published this statement in 2010

“The use of ultrasound has developed over the last 50 years into an indispensable first-line test for the cardiac evaluation of symptomatic patients. The technologic miniaturization and improvement in transducer technology, as well as the implementation of educational curriculum changes in residency training programs and specialty practice, have facilitated the integration of focused cardiac ultrasound into practice by specialties such as emergency medicine. In the emergency department, focused cardiac ultrasound has become a fundamental tool to expedite the diagnostic evaluation of the patient at the bedside and to initiate emergent treatment and triage decisions by the emergency physician.”

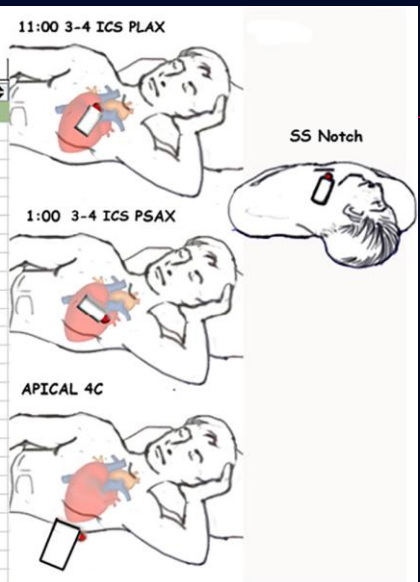
VS

Systematic Approaches

- ER rapid scan algorithms
  - Point of care focused
  - Rapid, Logic tree concept
  - Caution with limited approach
    - Missing/misinterpretation
    - Limitation of training
- Traditional full ECHO scan
  - Often difficult to complete
  - Time pressure
  - Potentially more expert

CHEST CASE

	A	B	C
1	VIEW	PARAMETER	VALUE
2	VIEW	PARAMETER	+/-/#/NT
3	PLAX	PC EFFUSION	
4		DISS FLAP	
5		PERICARD THICK	
6		VALVE VEGETATION	
7		AORTIC ROOT DIAM	
8		RV THICKENING?	
9	M MODE	aortic root excursion	
10		EF = 75.7-(2.5) x epss	
11		FS. (EF = 2X FS)	
12	PSAX	WALL MOT ABNORMAL	
13	AP4C OR SX	MCCONNEL'S SIGN	
14		WALL MOT AB	
15		COLLAPSE RA SYSTO	
16		COLLAPSE RV DIASTO	
17	aorta ss	TRANS DIAMETER	
18		LONG DISS FLAP	
19		SS VIEW DISSECT	
20	LUNG	A LINE	
21		B LINE	
22		PLEURAL EFFUSION	
23		PNEUMOTHORAX	
24	CHEST WALL		
25	ESOPHAGEAL		
26	EMOTIONAL		
27	IVC COLLAPS	TO ESTIMATE CVP	
28	Unequal Pulses		



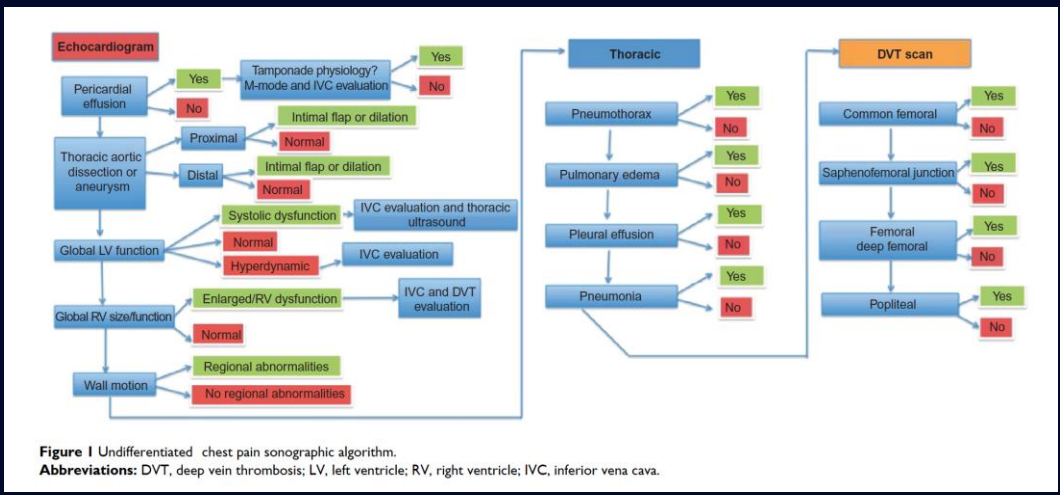
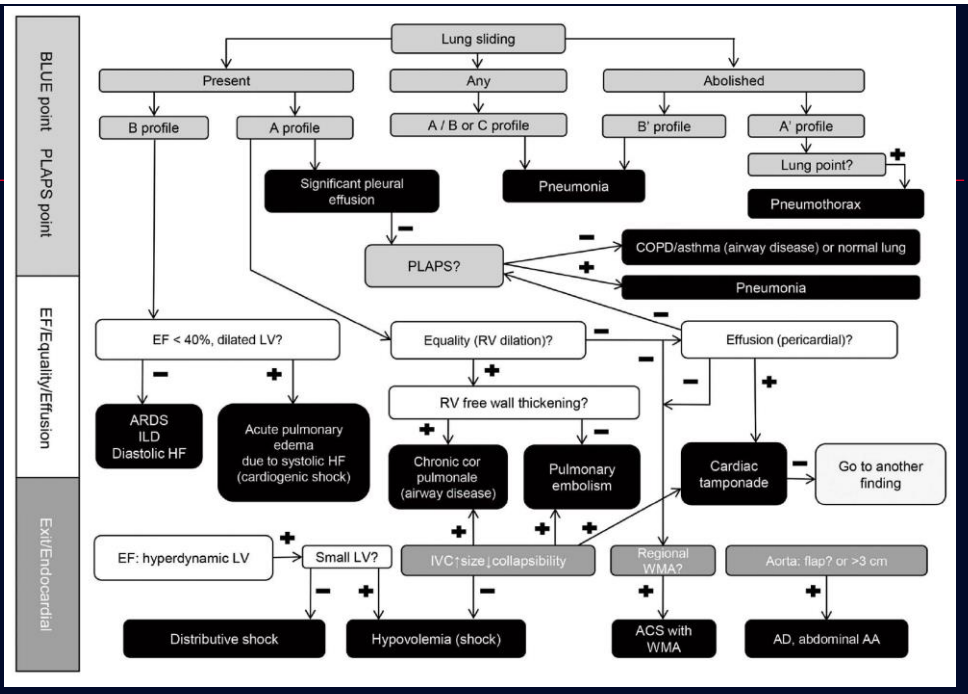


Figure 1 Undifferentiated chest pain sonographic algorithm.
Abbreviations: DVT, deep vein thrombosis; LV, left ventricle; RV, right ventricle; IVC, inferior vena cava.

Amini et al. Advances in Medical Education and Practice 2016:7,293-300



Ahn JH et al. PLOS One Journal March 2017

Studies Chestpain evaluation in ER

- Sobczyk, Nycz and Zmudka in 2015
- excluded patients with acute STEMI, patients under 18, and patients whose body habitus was incompatible
- series of approximately 1100 patients
- Non-STEMI, over 70% had wall motion abnormalities
- thought not to have an ACS at all, echo abnormalities were found in 55%
  - Aortic dissection
  - Changes suggesting PE
  - Pleayral and pericadial effusion
  - Cardiac tumours
  - etc

Studies Chestpain evaluation in ER

- F.J. Mancuso, 2014 Archive of Brazilian Cardiology
- Point of care echocardiography was performed in a series of 100 patients
- 28 patients, the focused echocardiography confirmed initial diagnosis
- In 17 patients, the echocardiography changed the diagnosis:
  - ten with suspicious of heart failure,
  - two with pulmonary embolism suspicious,
  - two with hypotension without cause,
  - one suspicious of ACS,
  - one of cardiac tamponade and one of aortic dissection

Studies Chestpain evaluation in ER

- Ahn JH, Jeon J, Toh H-C et al
- PLOS One Journal March 2017
- SEARCH 8Es – a novel point of care ultrasound protocol for patients with chestpain, dyspnea or syptomatic hypotension in the emergency department
- Single centre: 12 months, 308 patients (184 male, 124 women) mean age 67.7 yrs
- Narrowed initial diagnosis 2.5 ± 1.5 vs 1.4 ± 0.7 $p<0.001$
- Overall:
  - sensitivity 90.9%,
  - specificity 99.0%,
  - positive predictive value 89.7%,
  - negative predictive value 99.0%

Choice of imaging modality

- Sensitivity and specificity of the test for problem suspected
- Risk of transportation to remote point of hospital (CT, MRI)
- Echocardiography
  - Device to patient
  - Point of care triage
  - No ionizing radiation
  - Indicated in the majority of serious cardiac emergencies

Sensitivity and Specificity of Echo in chest pain

Condition	Sensitivity %	Specificity %
Asthma and COPD	89.0	97.0
Infectious endocarditis (children)	86.0	
Infectious endocarditis (adults)	34.2	99.0
Pericardial effusion	95.0	91.0
Pericardial tamponade	85.0	92.0
Pericardial (constrictive)	87.0	91.0
Pneumonia	89.0	94.0
Pneumothorax	81.0	100.0
Pulmonary embolus (direct visual)	50.0	
Pulmonary embolus(indirect signs)	93.0	81.0
Pulmonary embolus: DVT + Neg lung scan	81.0	99.0
Pulmonary oedema	97.0	95.0
Thoracic aortic aneurysm	78.0	
Wall motion abnormality (CAD)	90-95	80.0

Adapted from Colony, et al. American J of Emergency Medicine 2017

Challenges for Echo in the acute setting

- Patient habitus
  - Upright or prone patient
- Patient access and windows
  - Unable to position
  - Ventilated
  - Dressings and lines
  - Rapidity
  - Pneumothoracic, pneumomediastinum
  - Trauma – head, neck, thorax
- Interpretation of images in acute setting
  - Abnormal loading conditions
  - Ventilated –positive pressure

Recommendations for echocardiography in patients with acute chest pain

Recommended:

- Evaluation of acute chest pain in patients with suspected myocardial ischaemia, non-diagnostic ECG and cardiac necrosis biomarkers, and when resting echocardiogram can be performed during the pain;
- Evaluation of acute chest pain in patients with underlying cardiac disease (valvular, pericardial or primary myocardial disease);
- Evaluation of patients with chest pain and haemodynamic instability unresponsive to simple therapeutic measures;
- Evaluation of chest pain in patients with suspected acute aortic syndromes, myocarditis, pericarditis or pulmonary embolism.

Not recommended:

- Evaluation of chest pain in patients for which a non-cardiac aetiology is apparent;
- Evaluation of ongoing chest pain in patients with a confirmed diagnosis of myocardial ischaemia/infarction.

Eur Heart J Cardiovasc Imaging. 2014;16(2):119-146European Heart Journal – Cardiovascular Imaging 2015, 16:119-46

Acute coronary syndromes

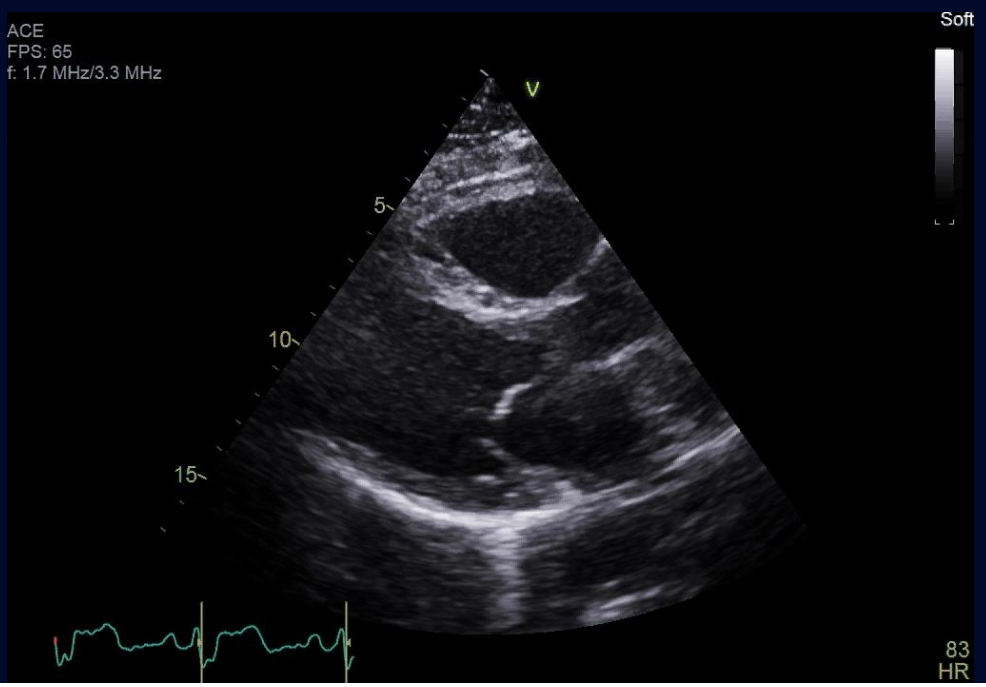
ECG in chest pain

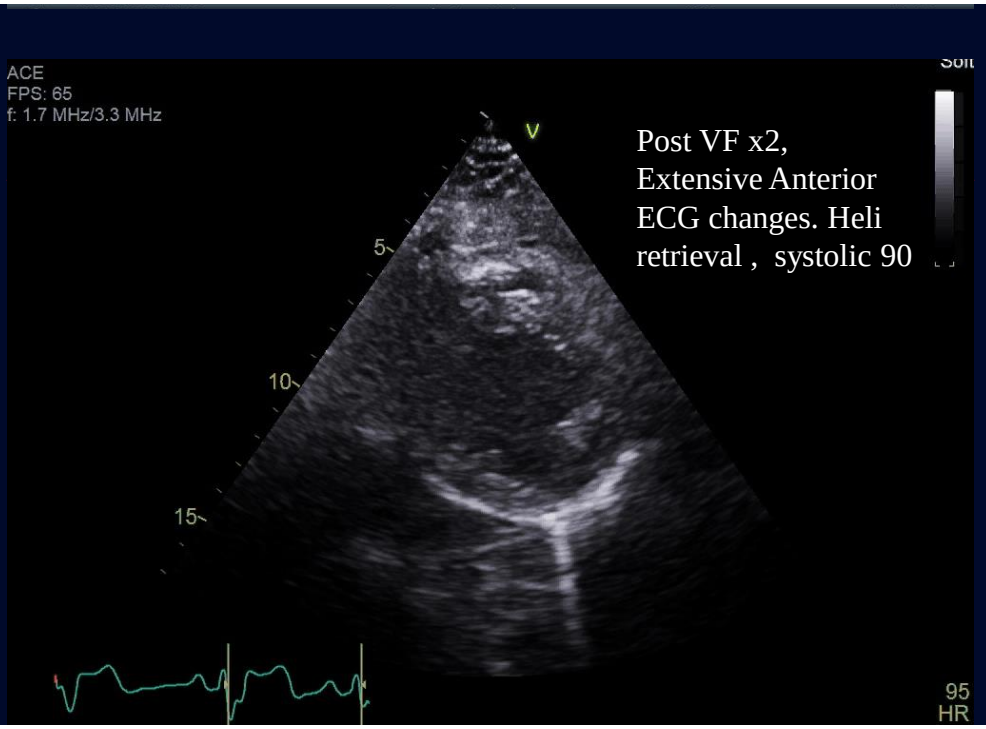
- Remains key initial step
  - Highly specific for STEMI (definition)
    - ECHO still highly recommended in STEMI cases
  - Highly fallible
  - Normal vs non-specific vs Bundle branch block
  - Pre-existing changes no comparator

Echo in ACS –Acute indications

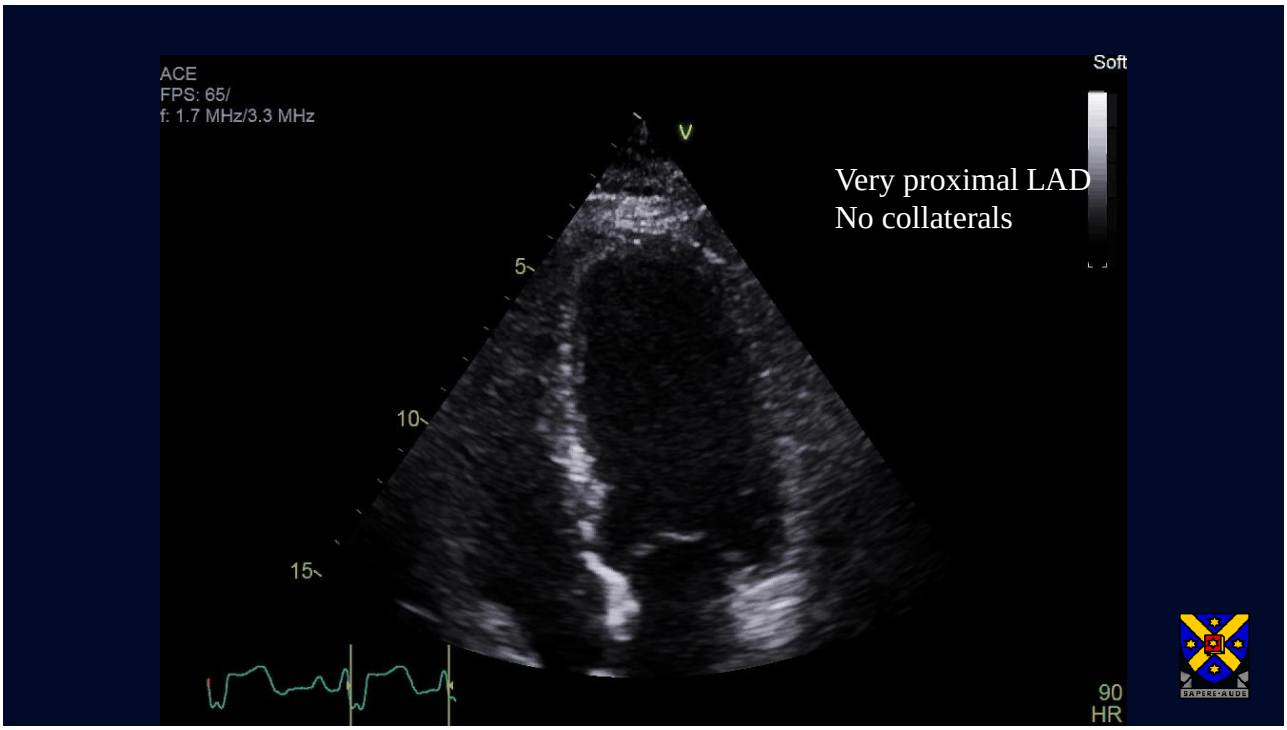
- Triad Chest pain,ECG changes and hsTrop
- Acutely “inconclusive” – common
- Echo valuable bedside triage
- Limitations:
  - Wall motion abnormalities in ischaemia reversible and non-specific
  - If present ischaemia vs necrosis, old vs new, other
  - High sensitivity, low specificity

- Diagnosis
- Location and extent
- Overall LV/RV function
- Complications
- Rule out CAD
  - Stress
  - Contrast





Post VF x2, Extensive Anterior ECG changes. Heli retrieval , systolic 90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Very proximal LAD
No collaterals
90
HR


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Soft
V
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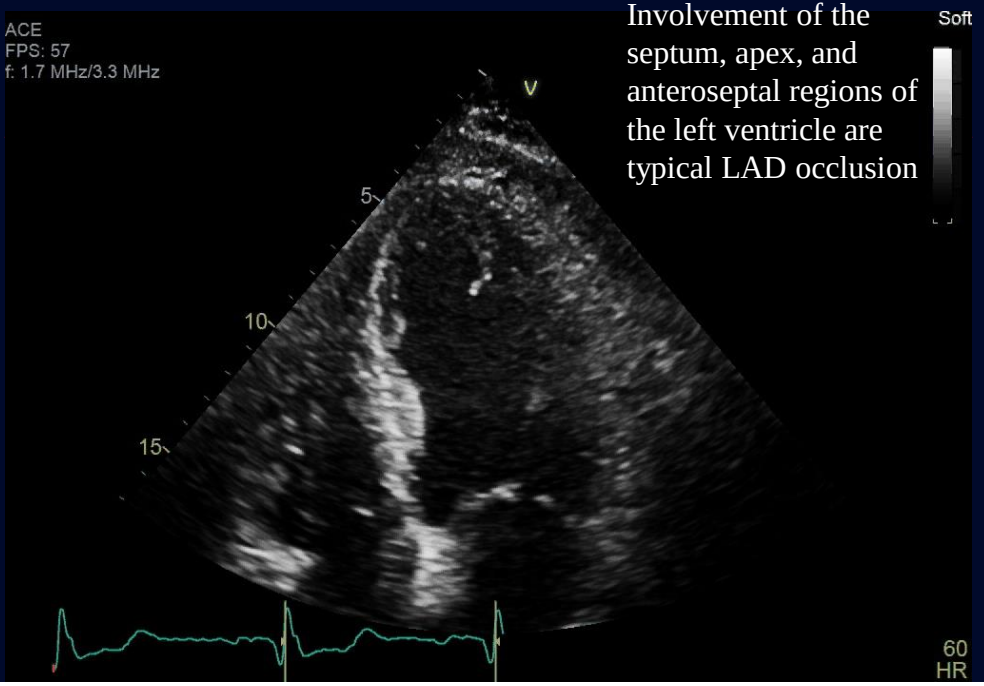
HR

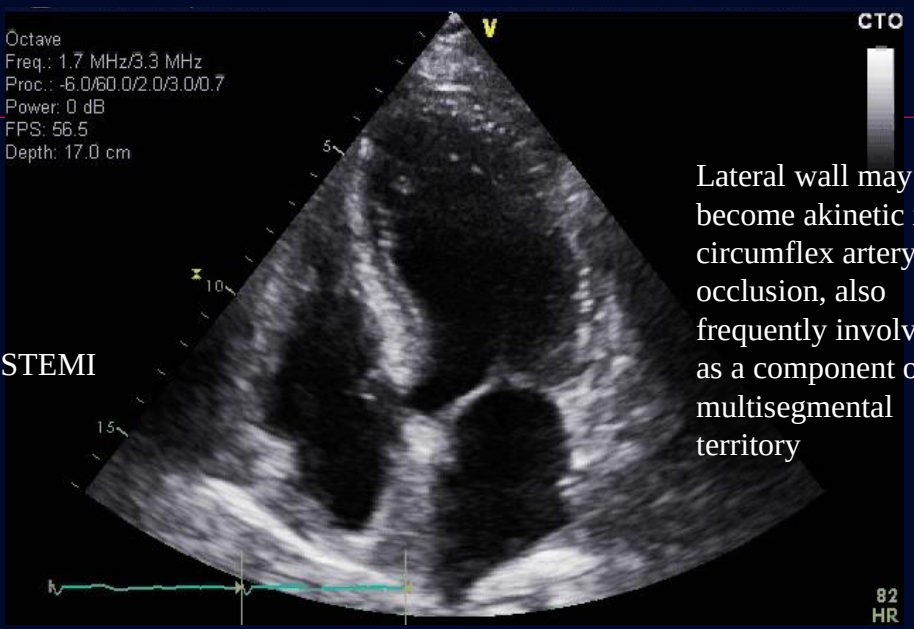
Mid LAD
Collaterals
present



Involvement of the septum, apex, and anteroseptal regions of the left ventricle are typical LAD occlusion

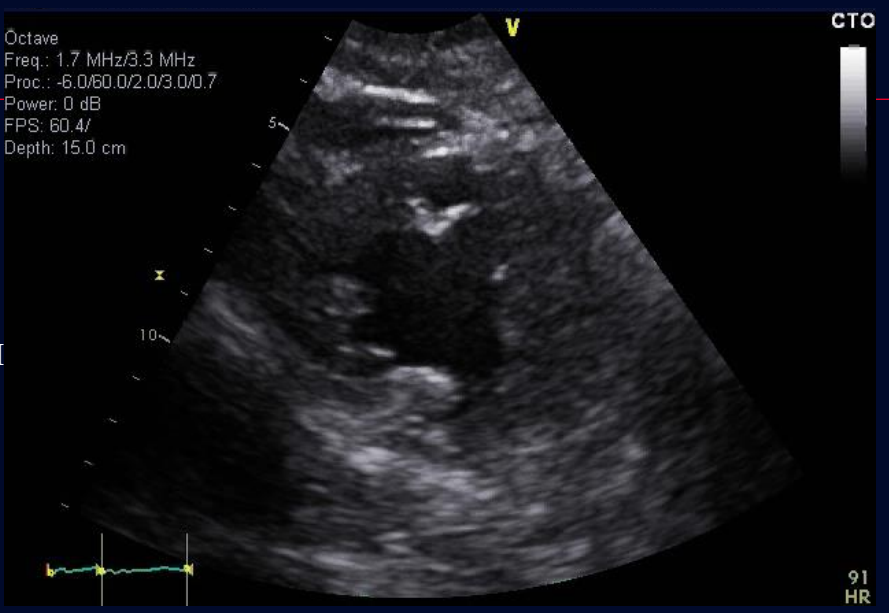
Cx STEMI angio

Cx STEMI

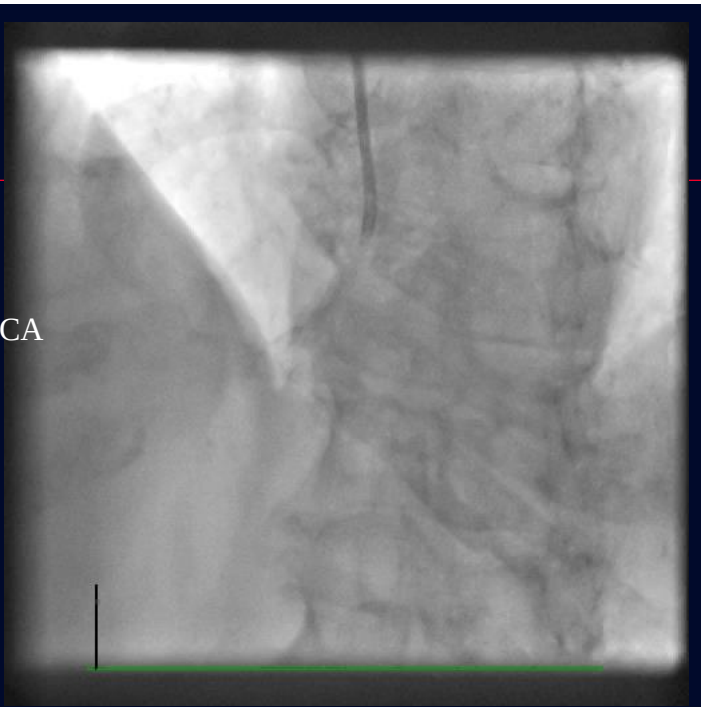


Lateral wall may become akinetic in circumflex artery occlusion, also frequently involved as a component of multisegmental territory

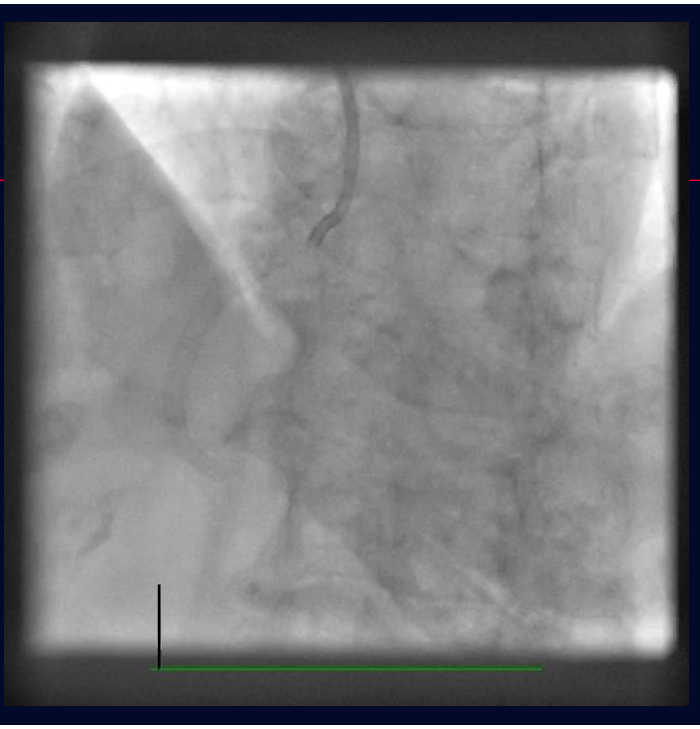
Cx
STEMI
PSAX

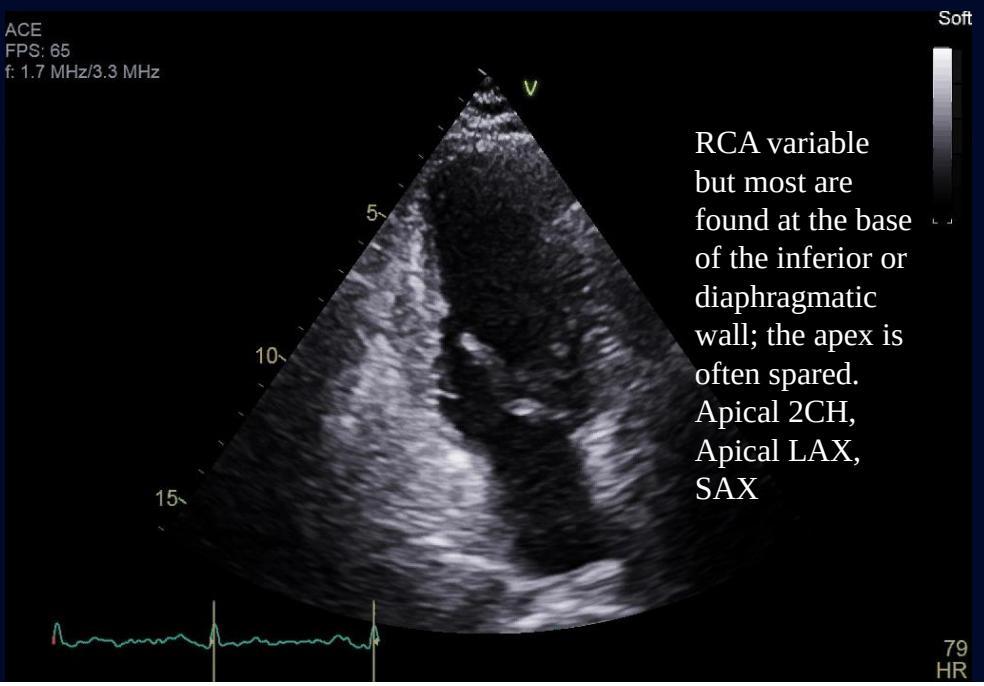


Dominant RCA
STEMI
Pre-PCI

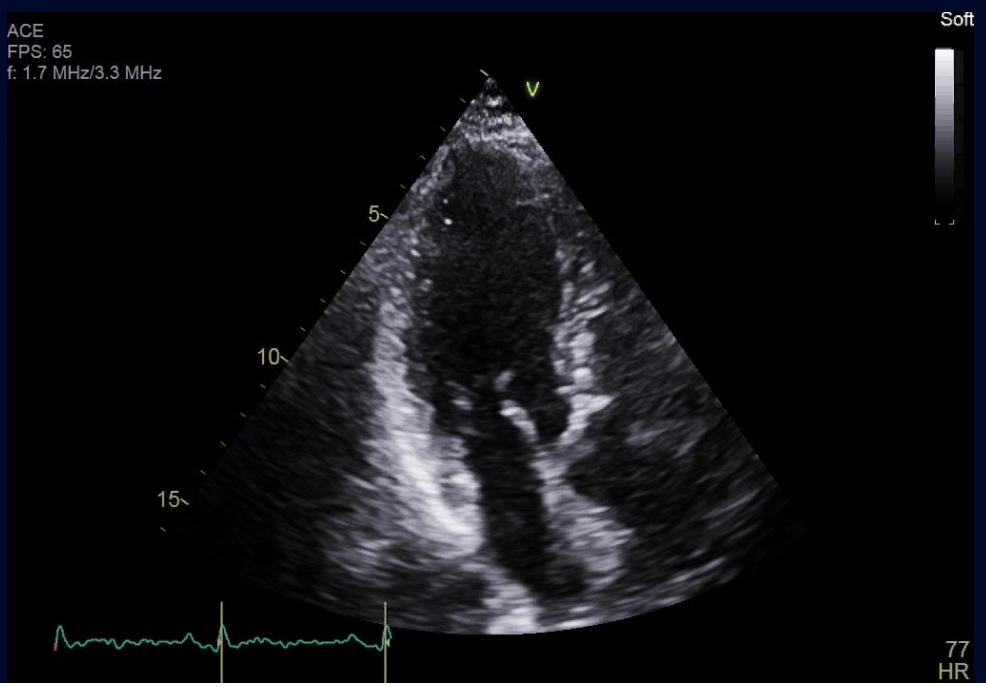


Post
PCI
Inf
STEMI

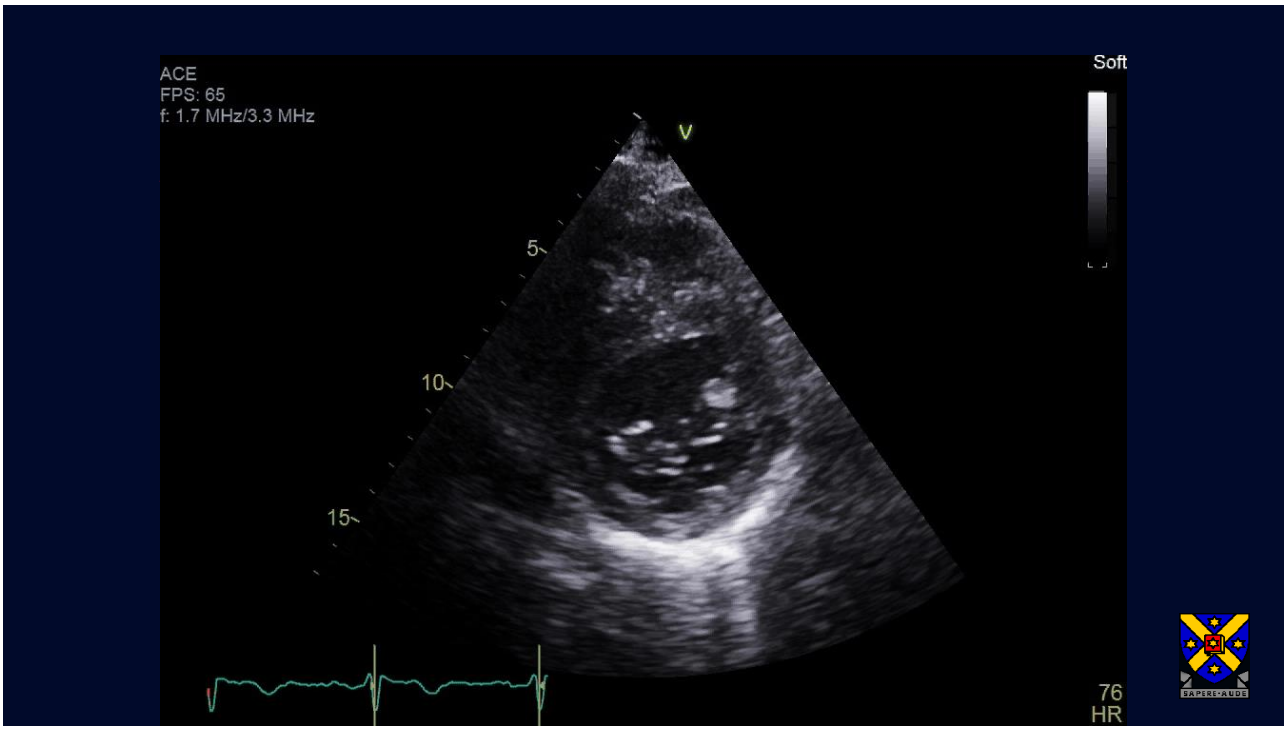




RCA variable but most are found at the base of the inferior or diaphragmatic wall; the apex is often spared. Apical 2CH, Apical LAX, SAX



- Uncertain territory prior to STEMI PCI
  - Ideally every STEMI case should have imaging during setup in lab
  - Huge advantage
    - Territory
    - LV function
    - Valvular disease
    - RV infarction/function
    - Complications of MI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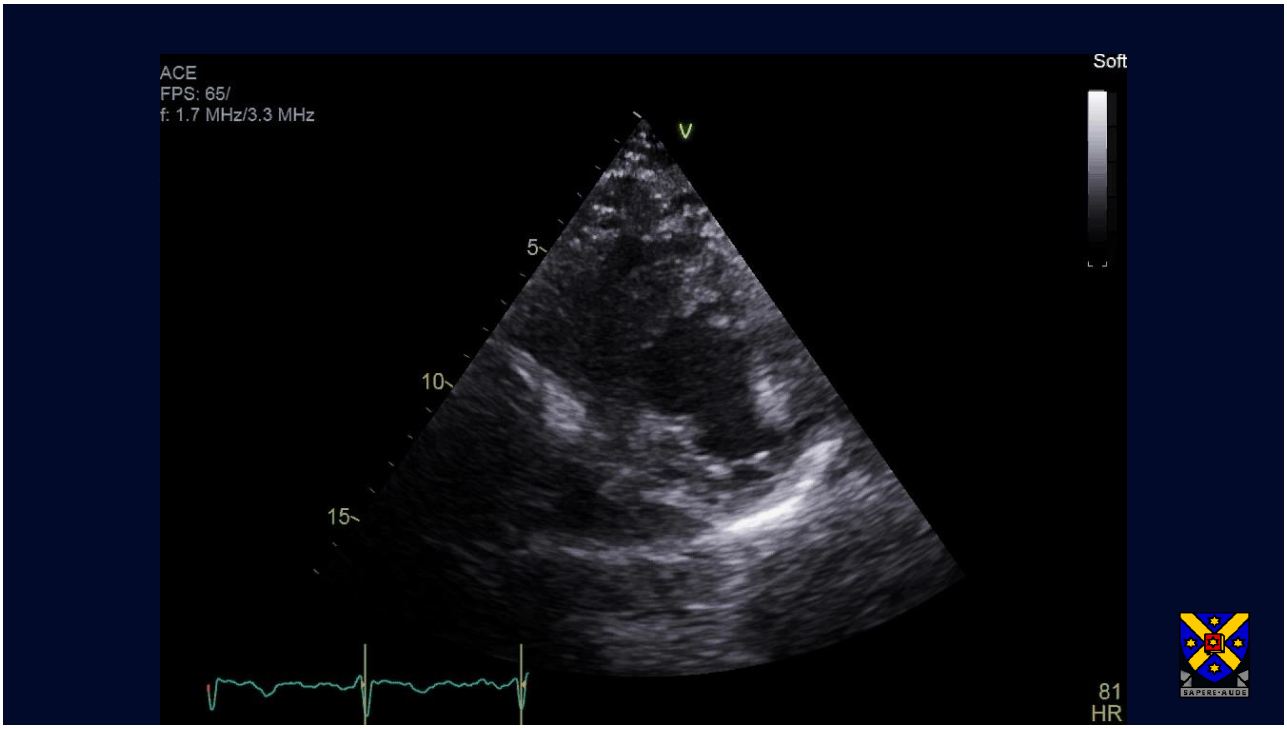
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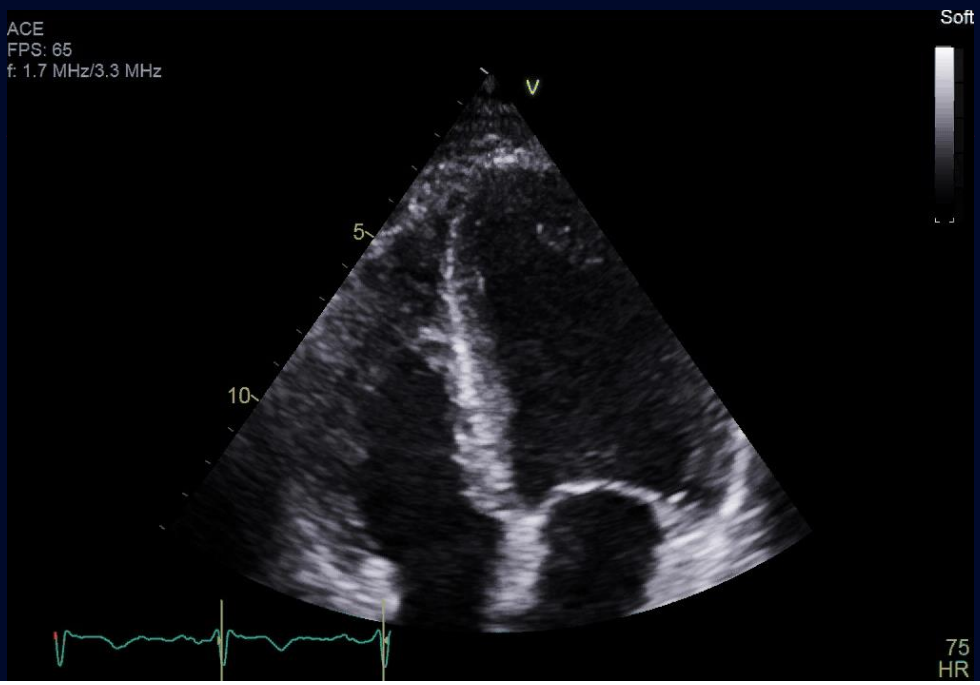
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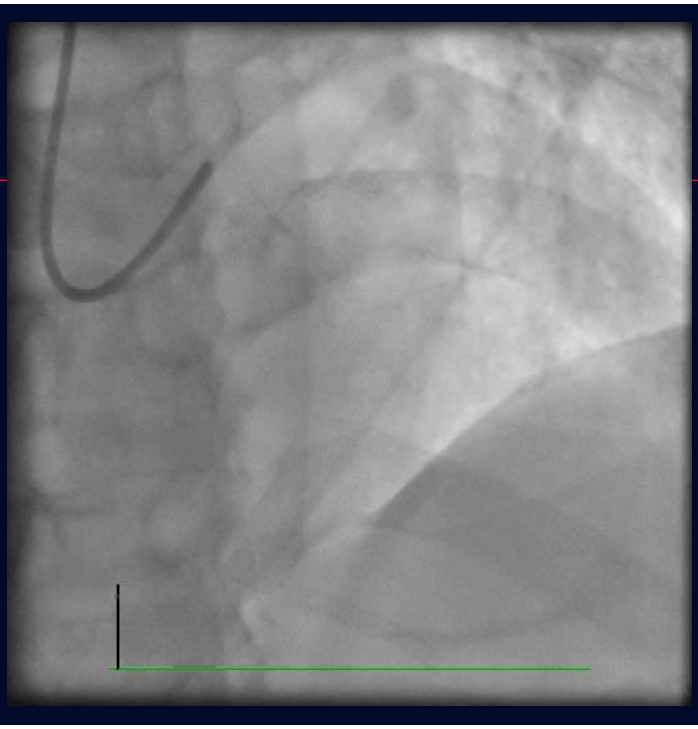
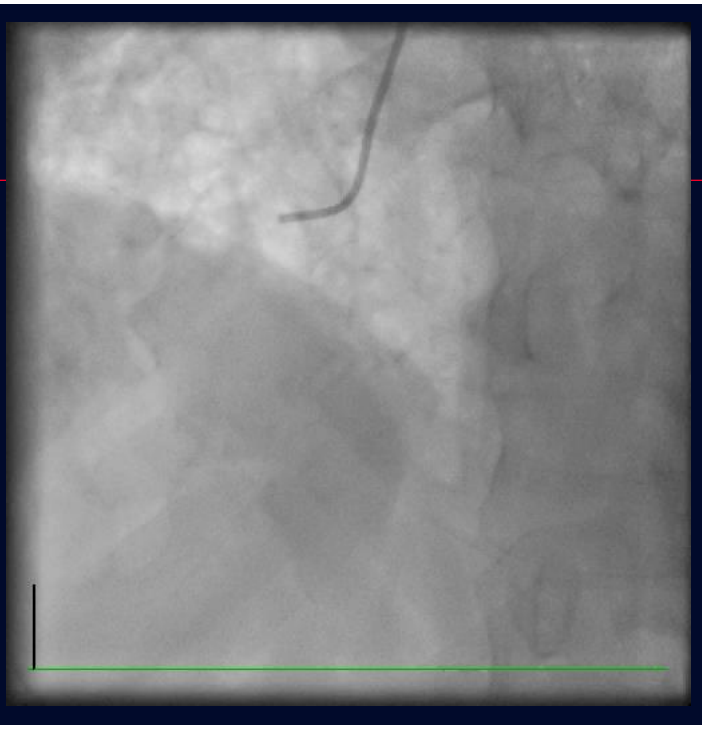
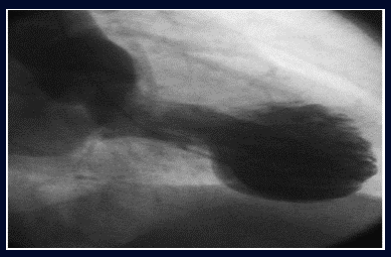


Fixed LAD

PDA pre



Tako-tsubo cardiomyopathy – overview



- Sato and Dote 1991
- 1-2% ACS presentations
- Post-menopausal women
- Frequently misdiagnosed
- Mimics MI
- Characteristic wall abnormalities
- Resemble Japanese octopus trap

- *Apical ballooning syndrome*, broken heart syndrome, scared to death, ampulla syndrome, *acute stress cardiomyopathy*, apical cardiomyopathy

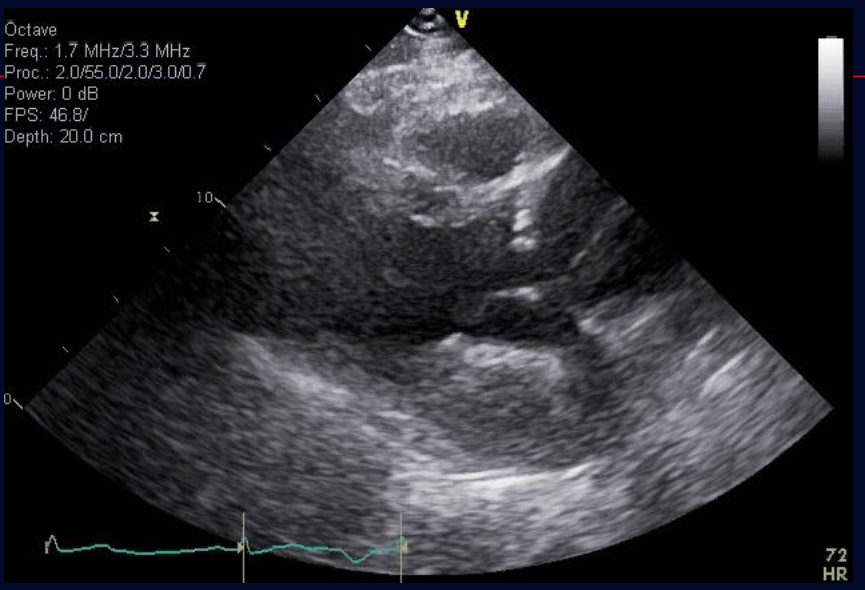
Tako-tsubo cardiomyopathy – clinical features

- Preceding stressful event
  - physical 17-22%
  - emotional 33-45%
- Chest pain or SOB in most patients
  - 50-60% CP at rest
- ST-T abnormalities on ECG +/- QT prolongation
- Elevation of cardiac enzymes
- Absence of CA narrowing on angiography
  - Case series 2009 (Gaibazzi) - bystander lesions >50% included
- Balloon-like LV wall motion abnormality at apex
  - most cases abnormality extends beyond perfusion territory of single CA
  - Case series 2007 (Kurowski) - midventricular abnormality 40%
- Good prognosis
  - complete recovery in vast majority within 4-8 weeks
  - in-hospital mortality 1%

Aortic dissection

- Life threatening emergency
- Chest pain and syncope
- Cornerstone is visualization of flap
  - Tamponade
  - Ao Valve incompetence
  - Wall motion ab's
- Type A (ascending) vs Type B (descending)
- TTE vs TEE
- Pitfall – reverberation artifact
- Triage to alternative imaging – CT contrast

Next on cath list after urgent transfer as Non-STEMI
– 64 yrs. Post CABG 7 years, ongoing pain, no ECG changes, looked sick



- Pulmonary embolism cases

Recommendations for echocardiography in patients with suspected/confirmed pulmonary embolism

Recommended:

- Suspected high risk of pulmonary embolism where shock or hypotension are present and CT is not immediately available
- For distinguishing cardiac vs. non-cardiac aetiology of dyspnoea in patients in whom all clinical and laboratory clues are ambiguous;
- For guiding the therapeutic option in patients with pulmonary embolism at intermediate risk.

Reasonable:

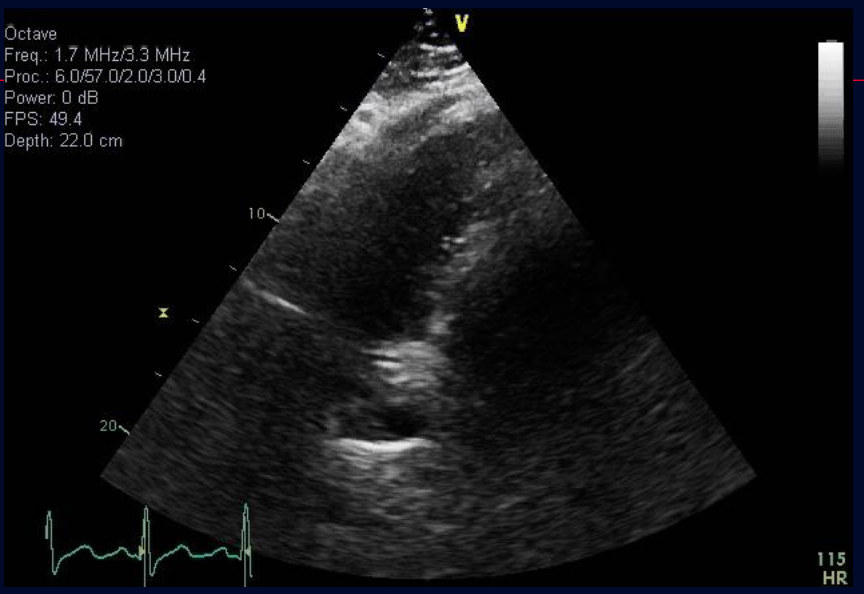
- Search for pulmonary emboli and suspected clots in the right atrium or ventricle or main pulmonary artery branches;
- For risk-stratification in non-high risk pulmonary embolism.

Not recommended:

- For elective diagnostic strategy in haemodynamically stable, normotensive patients with suspected pulmonary embolism.

Eur Heart J Cardiovasc Imaging. 2014;16(2):119-146European Heart Journal – Cardiovascular Imaging 2015, 16:119-46

Female 25 years, 7 days post knee injury
Chest pain to ER, hypotensive.



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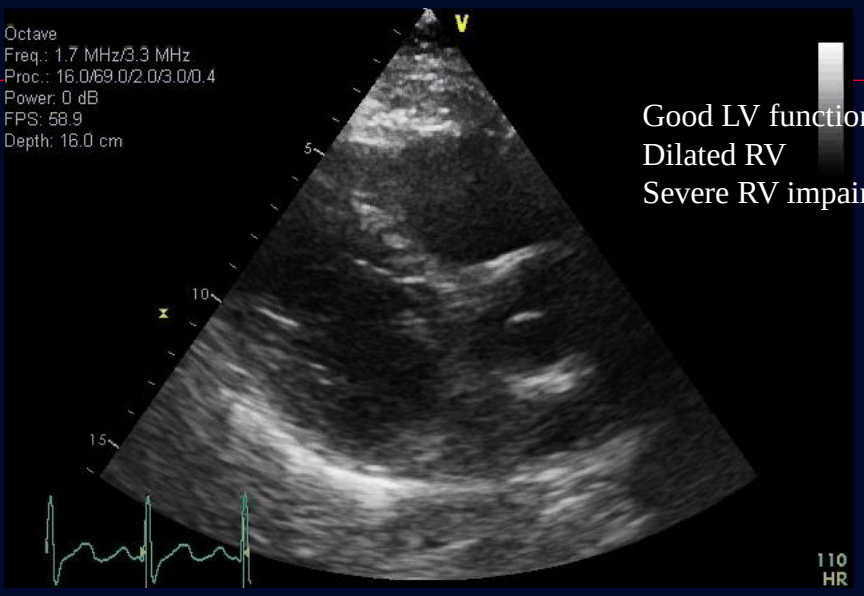
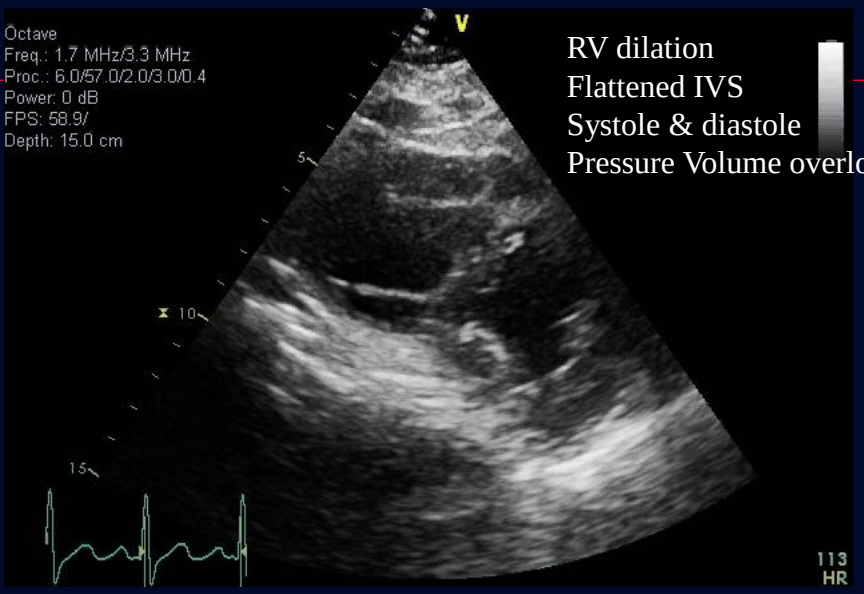


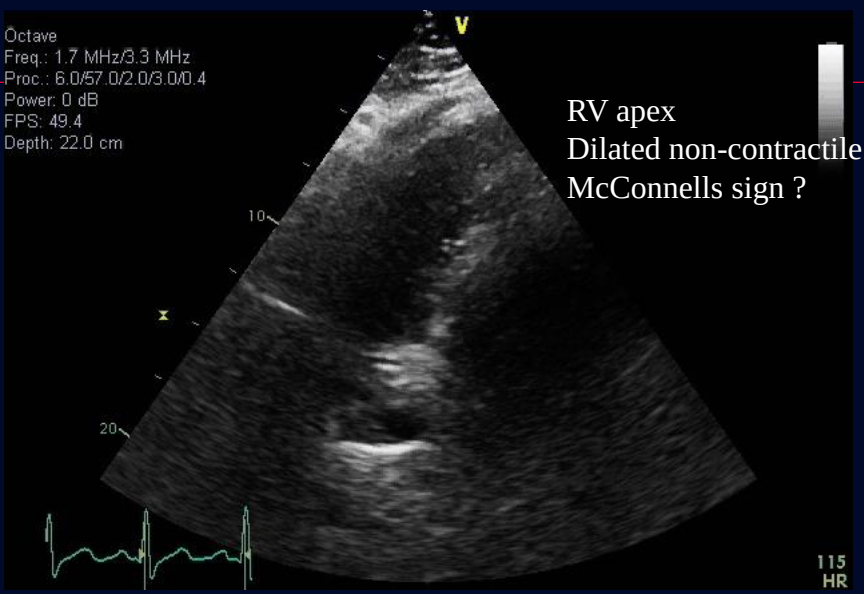
Good LV function
Dilated RV
Severe RV impairment

Female 25 years, 7 days post knee injury
Chest pain to ER, hypotensive.



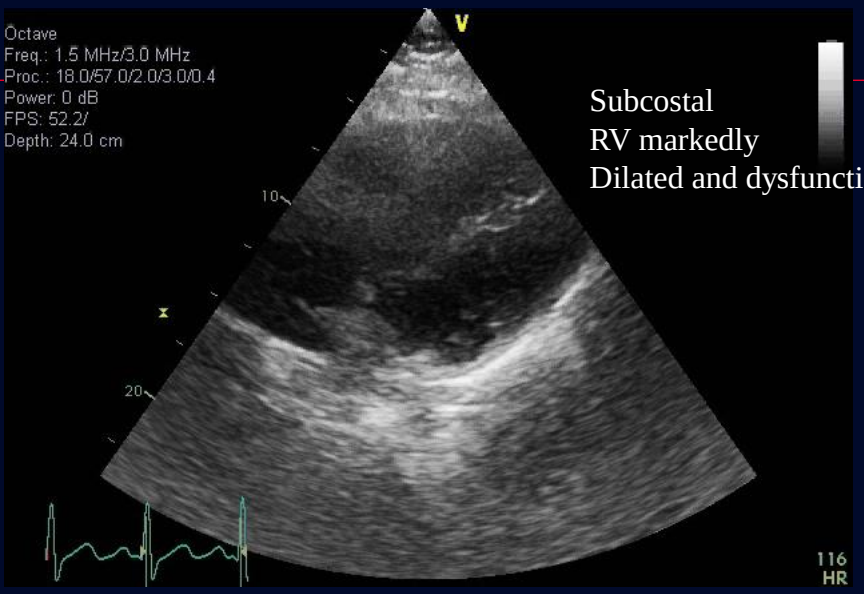
RV dilation
Flattened IVS
Systole & diastole
Pressure Volume overload

Female 25 years, 7 days post knee injury
Chest pain to ER, hypotensive.

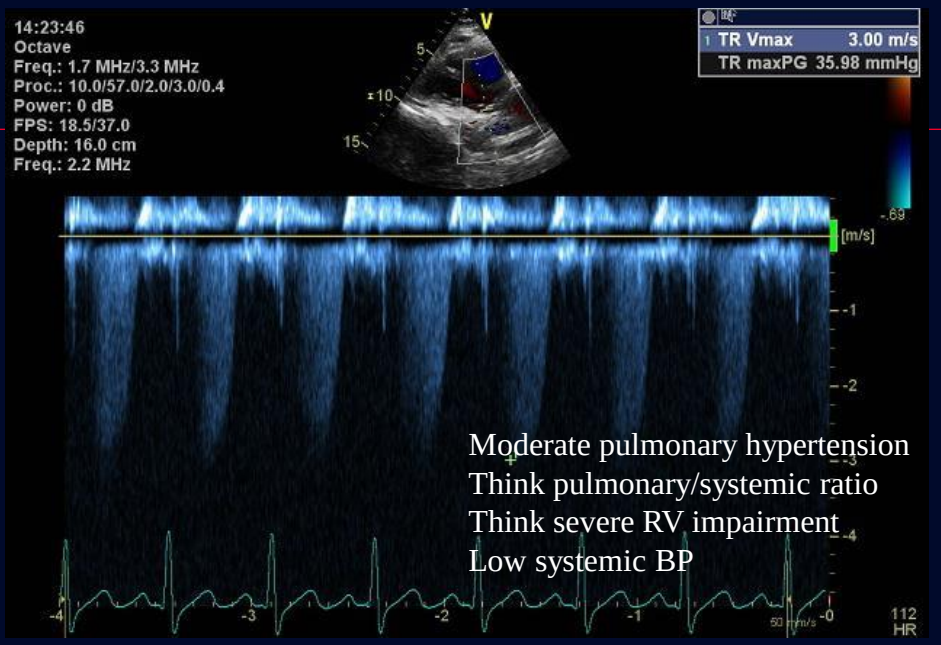


RV apex
Dilated non-contractile
McConnells sign ?

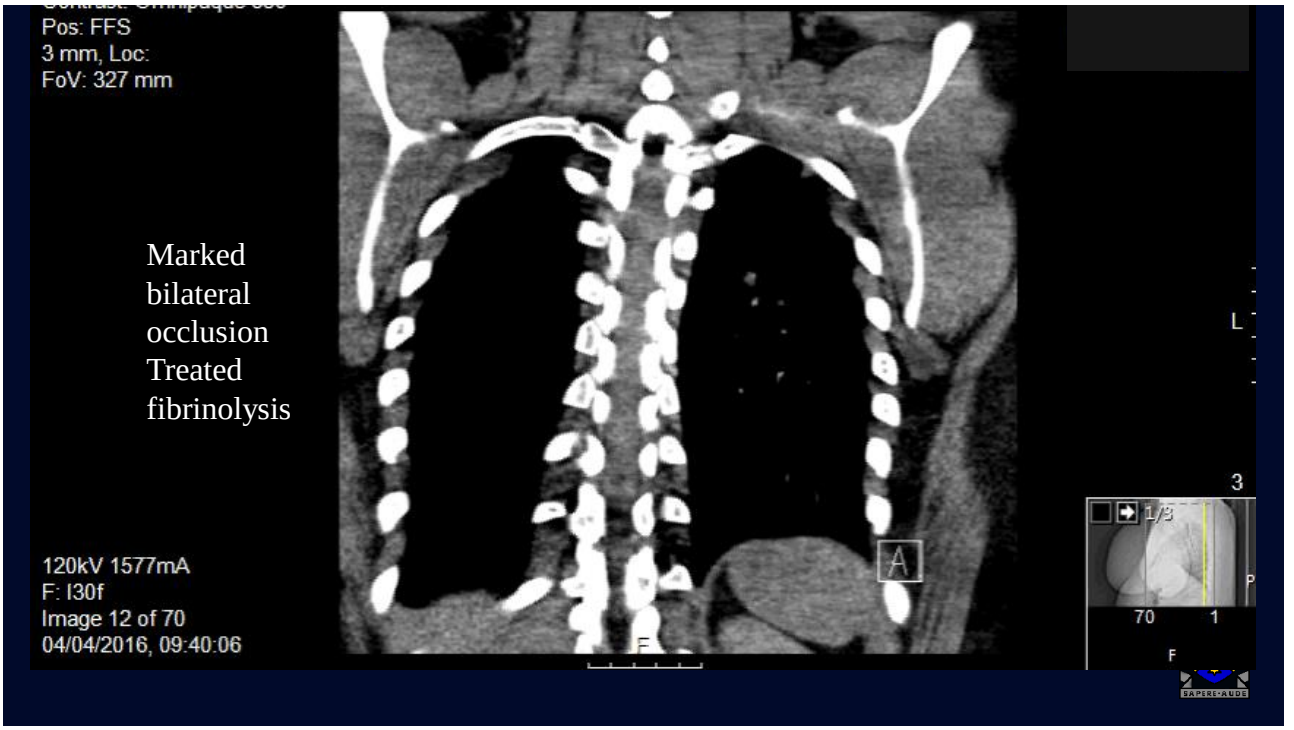
Female 25 years, 7 days post knee injury
Chest pain to ER, hypotensive.



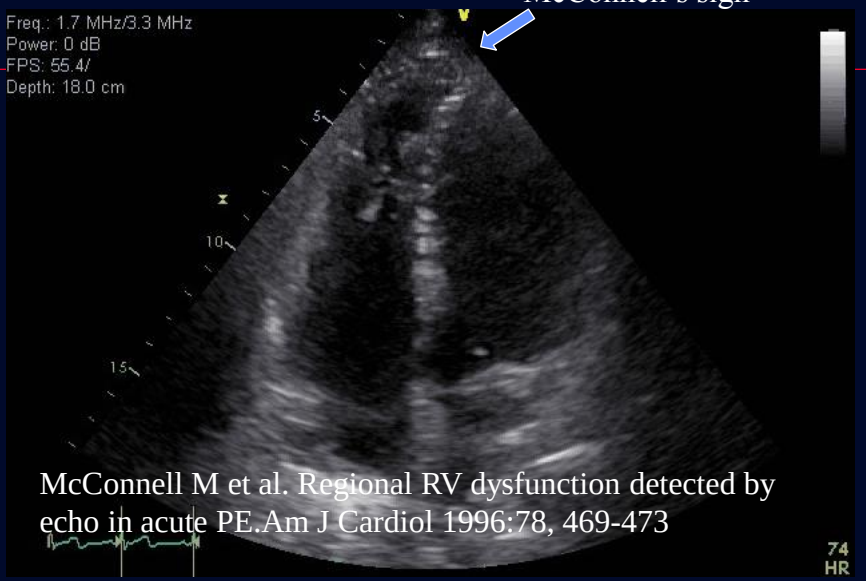
Subcostal
RV markedly
Dilated and dysfunction



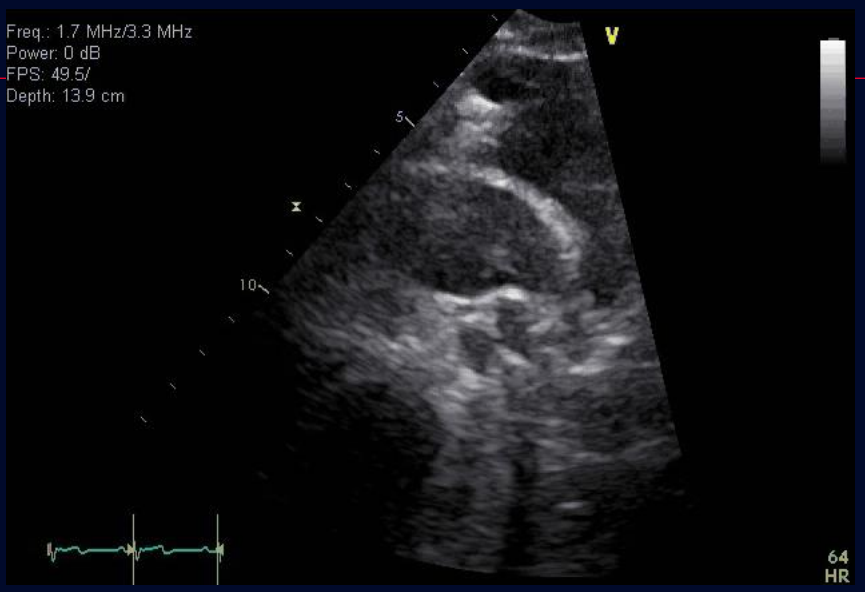
Moderate pulmonary hypertension
Think pulmonary/systemic ratio
Think severe RV impairment
Low systemic BP



35 year old, presents ER with chest pain. Bruised leg 4 weeks ago
Apparently well



McConnell M et al. Regional RV dysfunction detected by echo in acute PE.Am J Cardiol 1996:78, 469-473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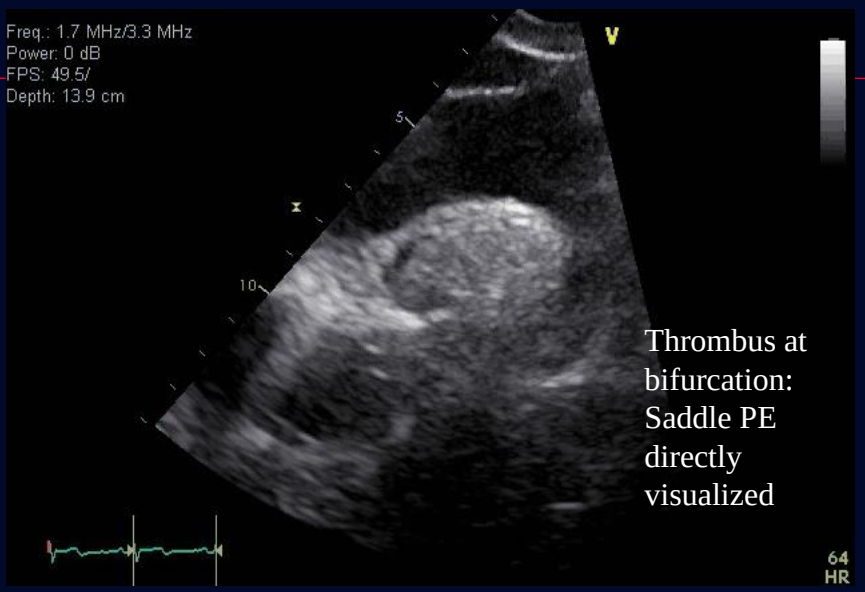
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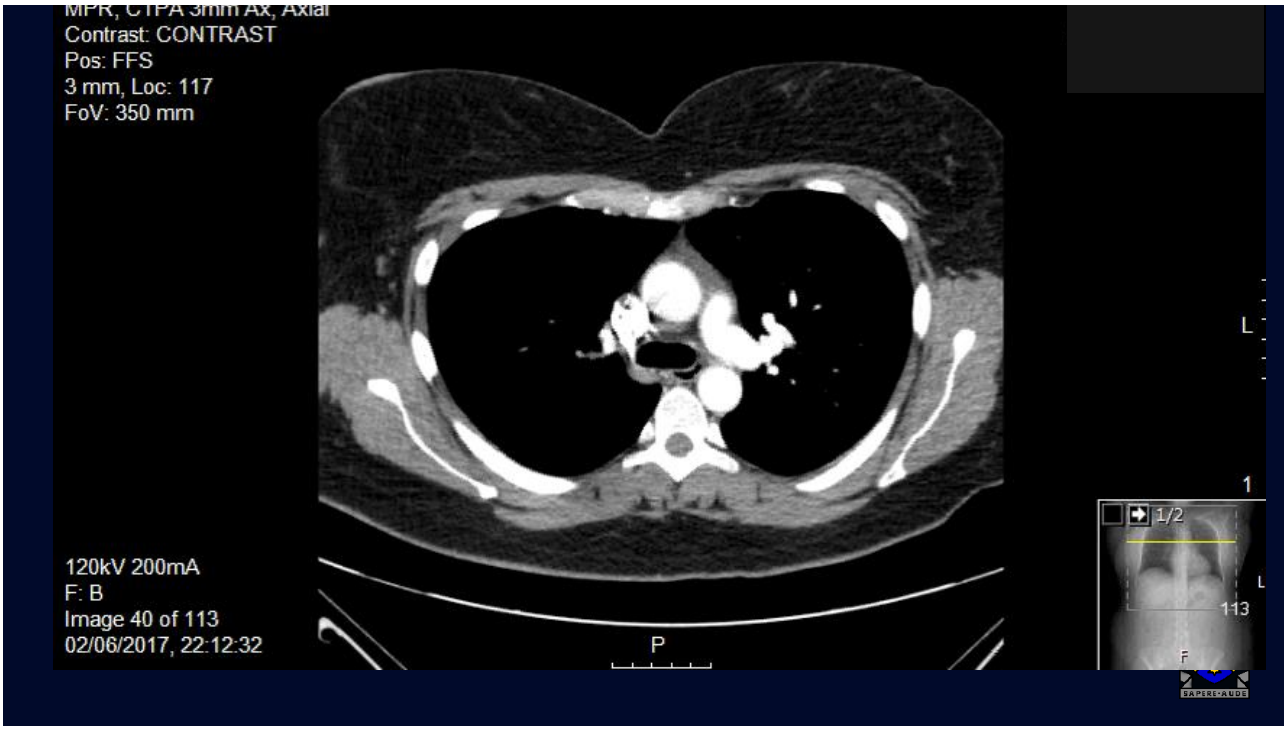
Thrombus at bifurcation: Saddle PE directly visualized
64
HR



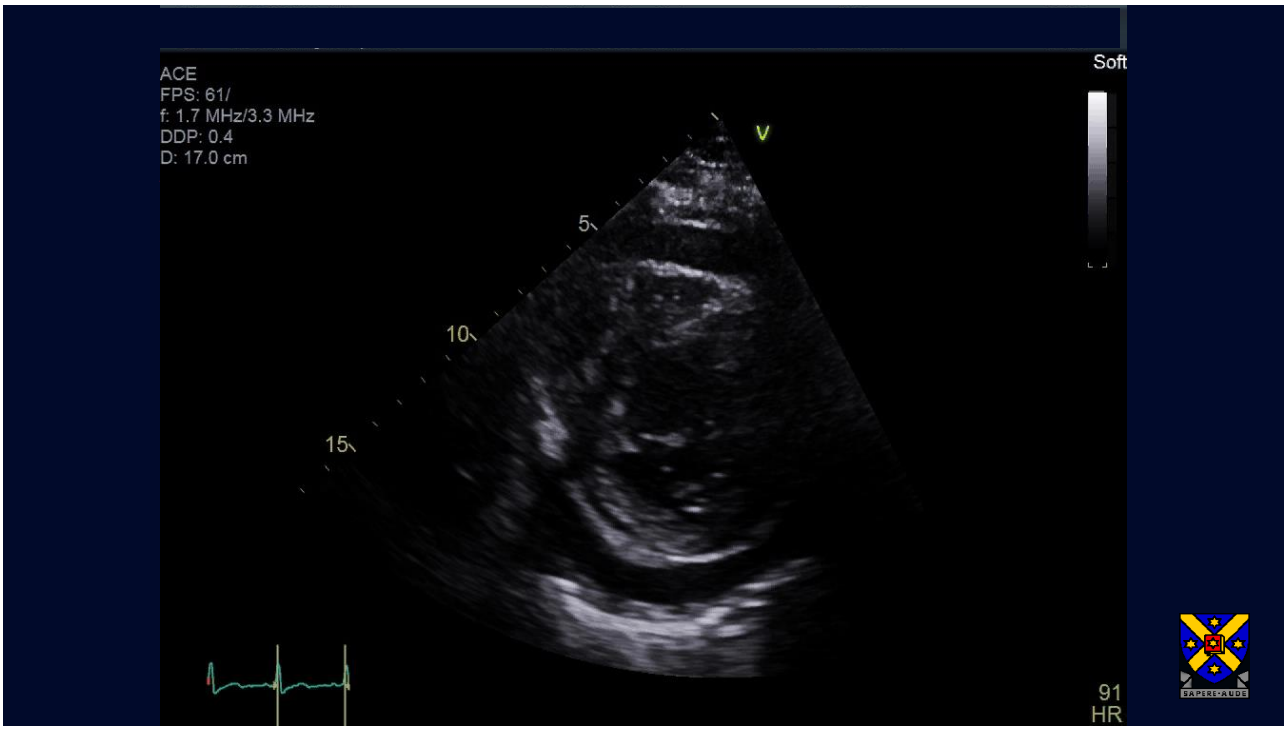
Causes of Pericarditis

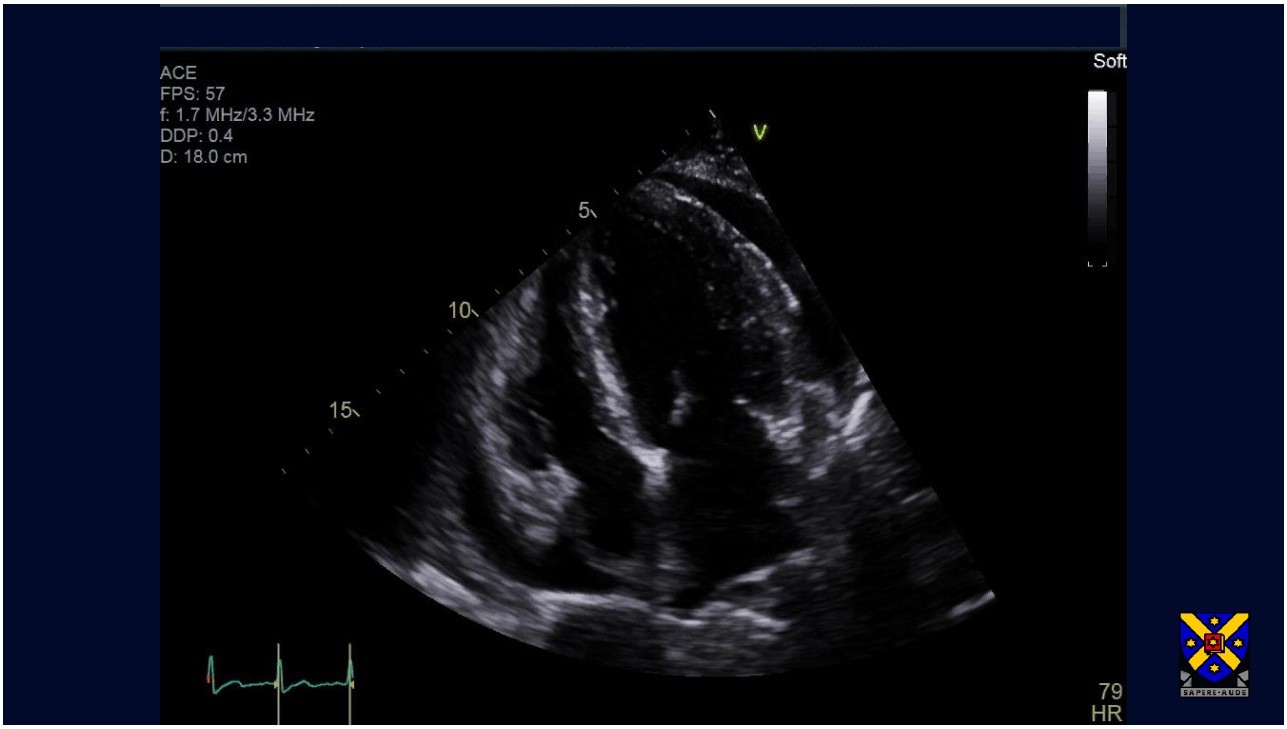
- Idiopathic
- Renal failure
- Viral infections
- Neoplastic
- Bacterial, tuberculous,
- Hypothyroidism
- Rheumatoid
- Systemic lupus
- Scleroderma, sarcoidosis
- Rheumatic fever
- Myocardial infarction/Dresslers syndrome
- Aortic dissection/Takotsubo
- Drugs/Irradiation/interventions
- Sjögren syndrome
- Mixed connective-tissue disease
- Reiter syndrome
- Ankylosing spondylitis
- Inflammatory bowel disease
- Wegener granulomatosis
- Vasculitis (eg, giant cell arteritis, polyarteritis)
- Polymyositis
- Behçet syndrome
- Whipple disease
- Familial Mediterranean fever
- Serum sickness

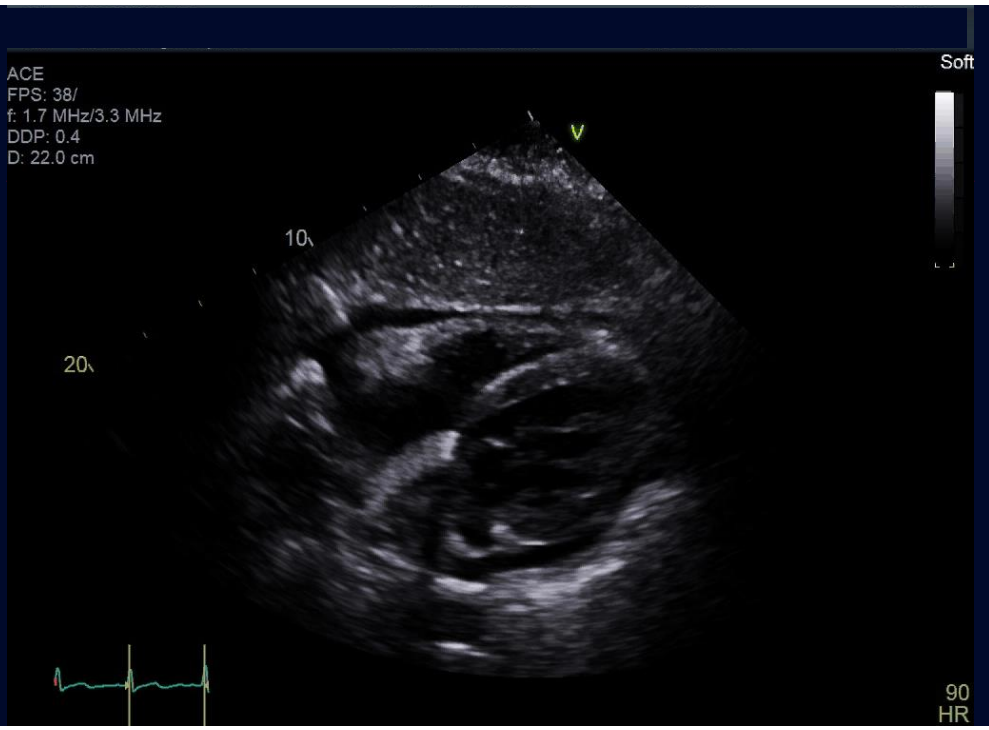
Pointers in clinical story

- Pleuro-pericardial features
  - Hurts to breath – splinting on inspiration
  - ↑ comfort leaning forward, shallow inspiration
  - Positional
- Unremitting, background discomfort
- Prolonged intense episodes:
  - too long for angina
  - Crippled by pain: “exquisite pain”

- Pericardial effusion – borderline tamponade

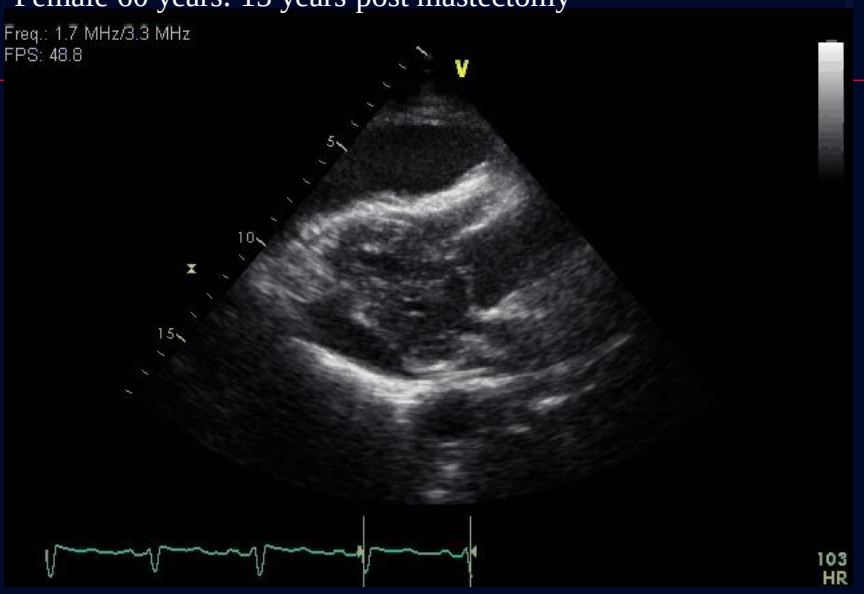

ACE
FPS: 61/
f: 1.7 MHz/3.3 MHz
DDP: 0.4
D: 17.0 cm
Soft
V
5
10
15
91
HR


ACE
FPS: 57
f: 1.7 MHz/3.3 MHz
DDP: 0.4
D: 18.0 cm
Soft
V
5
10
15
79
HR

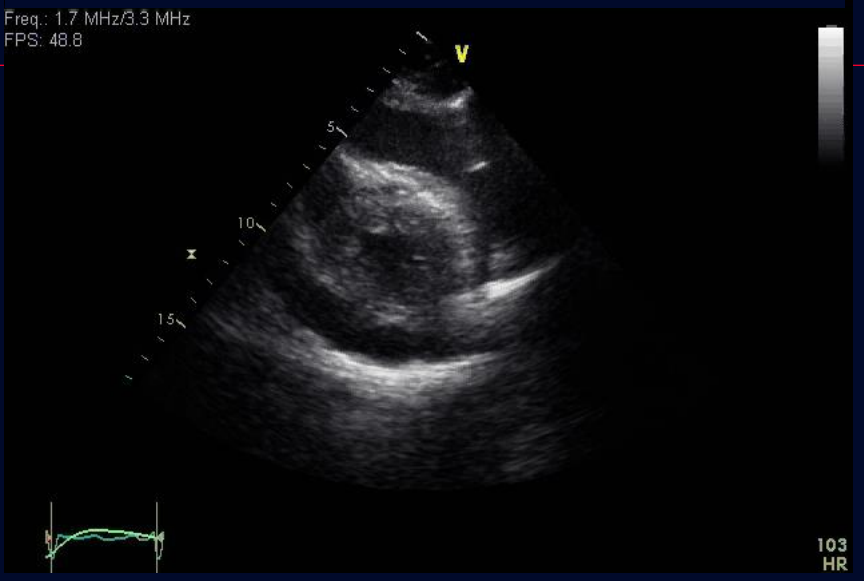


- Pericardial Tamponade

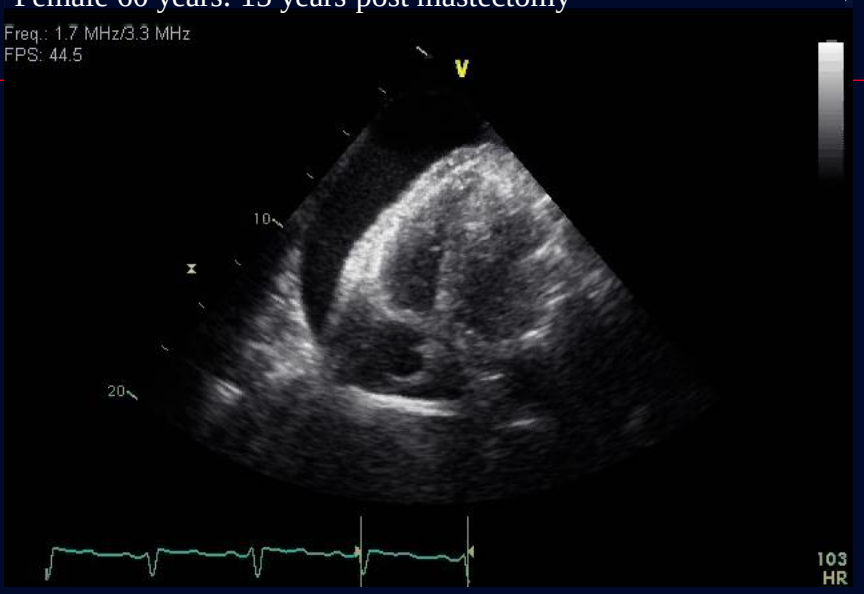
Chestpain and dyspnoea in ER
Female 60 years. 15 years post mastectomy



Chestpain and dyspnoea in ER
Female 60 years. 15 years post mastectomy



Chestpain and dyspnoea in ER
Female 60 years. 15 years post mastectomy

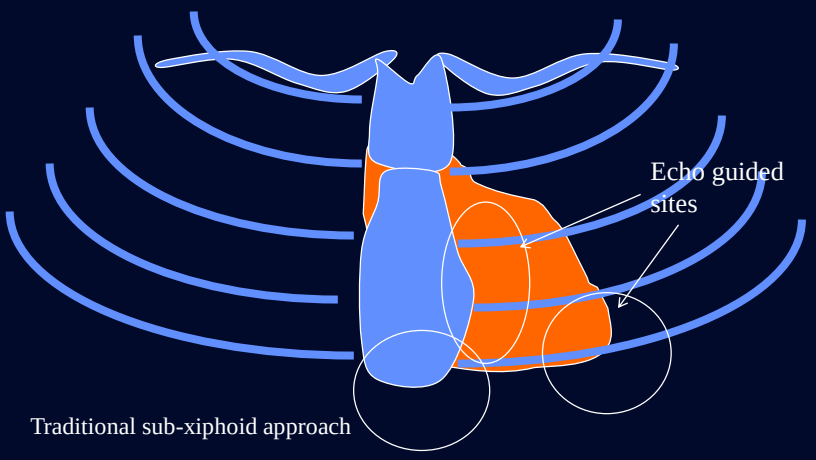


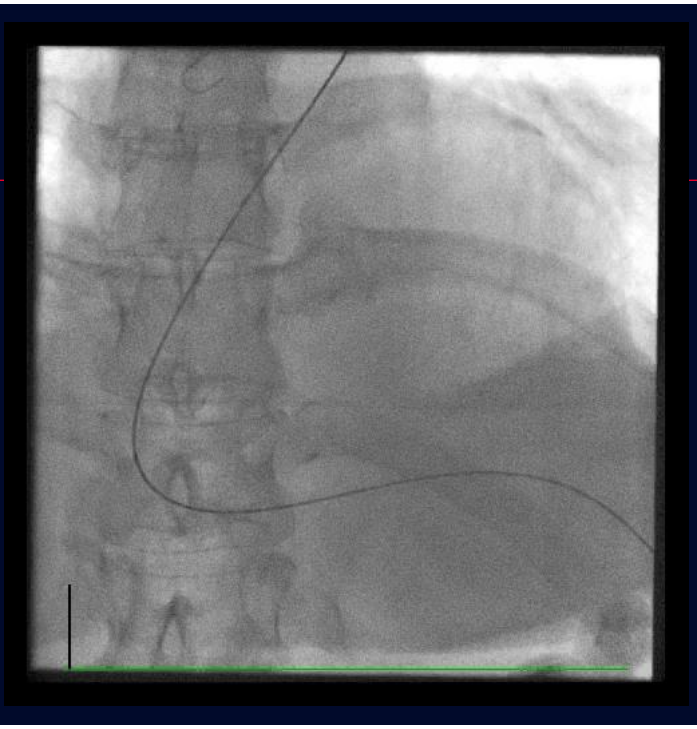
- Pericardial Aspiration

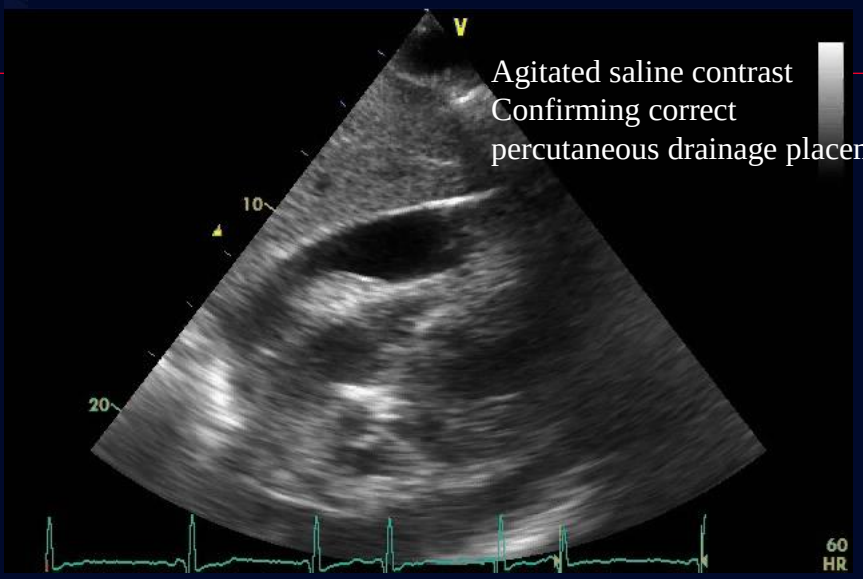
Draining a pericardial effusion

- Locate an area where you are close to the fluid from the surface
- Have ECG and BP monitoring on
- Angle to find a direction where you can hit fluid but not heart
- Mark this point on chest wall
- Instill lignocaine and advance needle between intercostal space
- Advance small distance aspirate, repeat
- Once in effusion draw off and inspect, remember how deep
  - Clear, bloody, purulent
- If you hit heart, lots of ectopics
- Take larger bore needle and advance, aspirate
  - In tamponade a small volume will make a big difference
- Can place guide wire and aspiration pigtail catheter

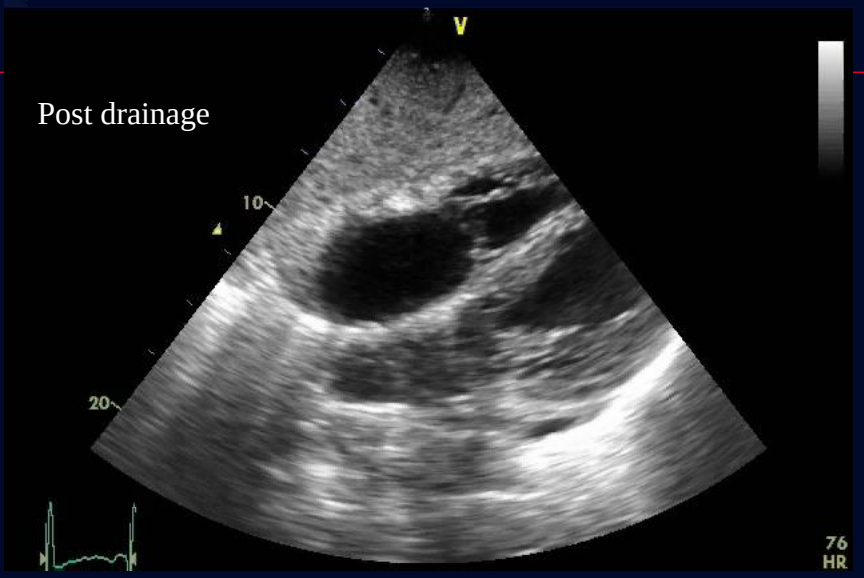
Surface Anatomy: Sites for pericardial aspiration



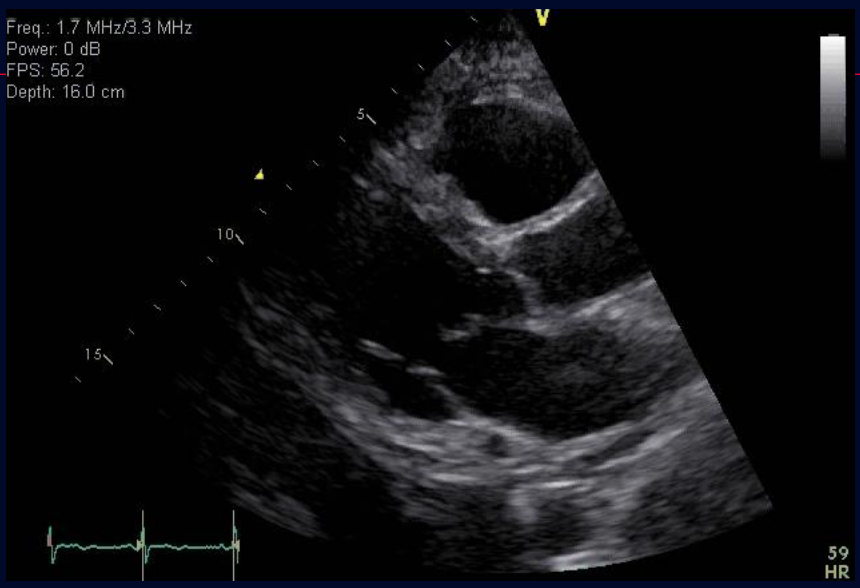




Agitated saline contrast
Confirming correct
percutaneous drainage placement



- Small pericardial effusion with large left pleural effusion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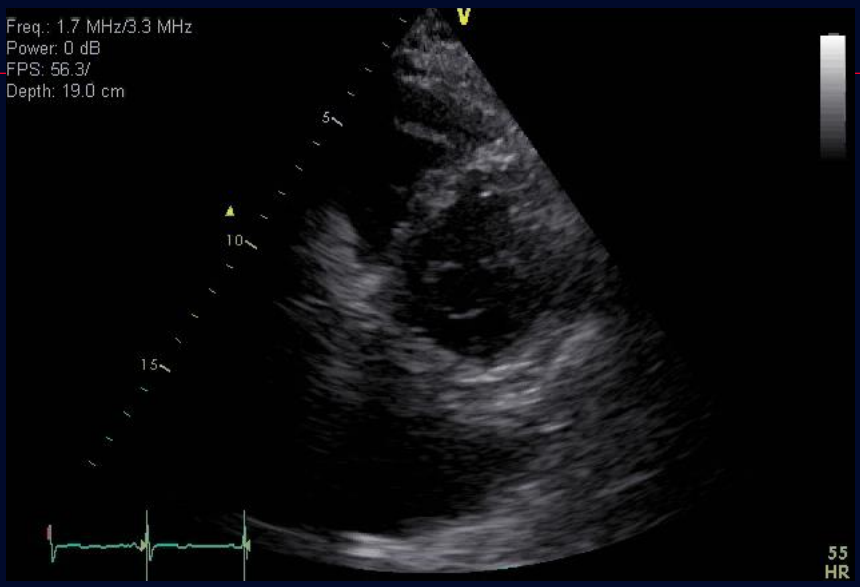
FPS: 56.2
Depth: 16.0 cm
5
10
15
59
HR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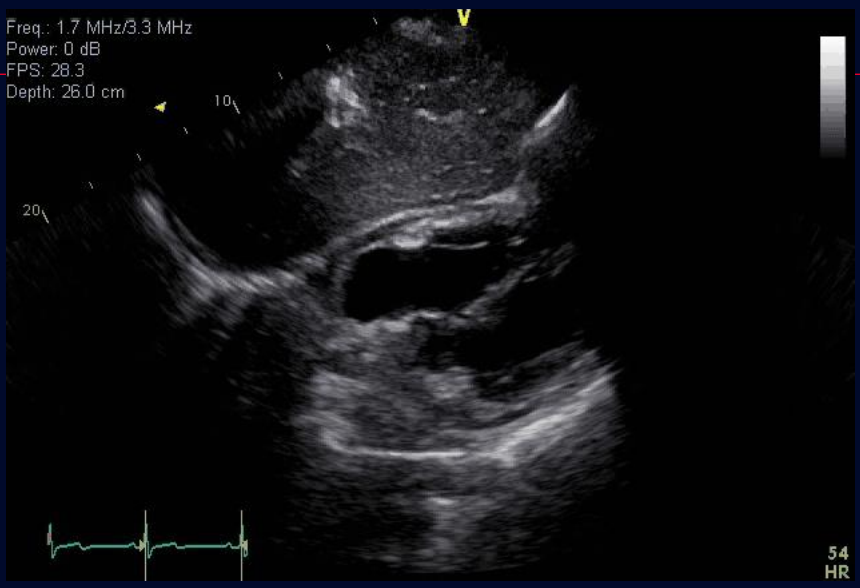
Power: 0 dB
FPS: 56.3/
Depth: 19.0 cm
5
10
15
55
HR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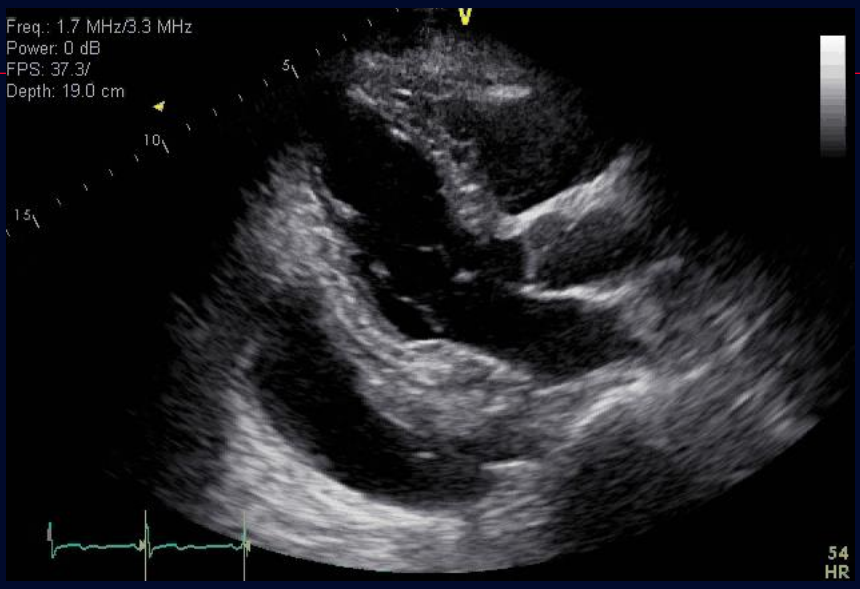
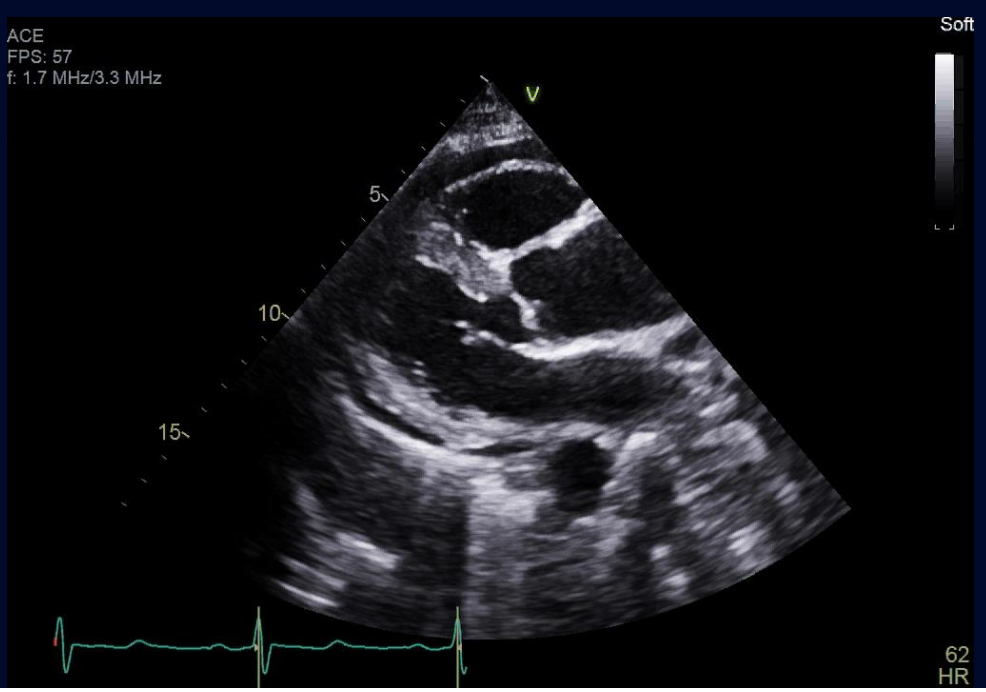
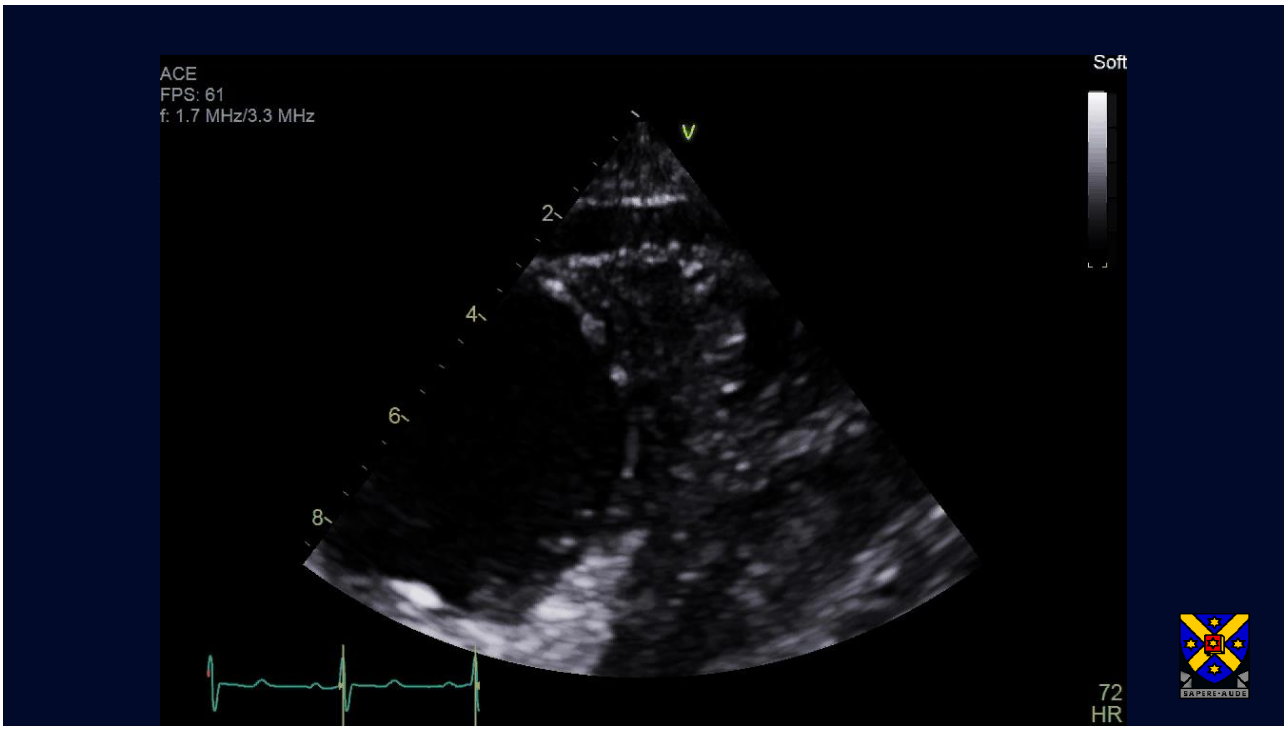
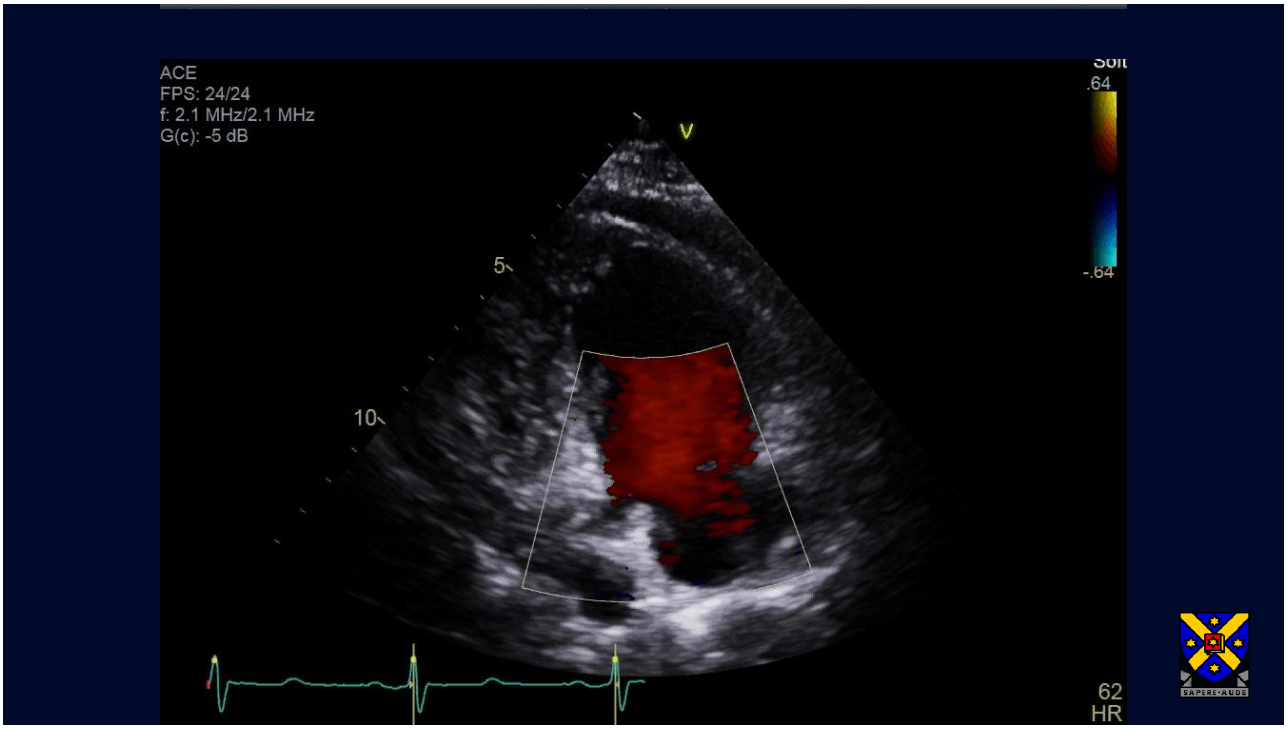
Power: 0 dB
FPS: 28.3
Depth: 26.0 cm
10
20
54
HR

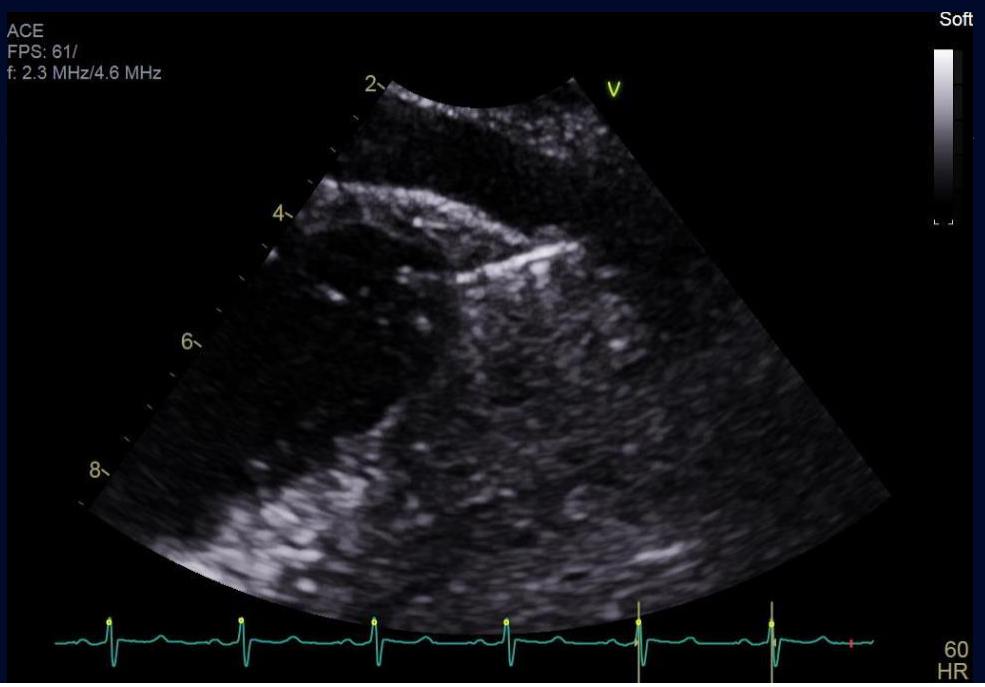

Freq.: 1.7 MHz/3.3 MHz
Power: 0 dB
FPS: 37.3/
Depth: 19.0 cm
5
10
15
54
HR

- Chestpain 3 weeks post DDD pacemaker



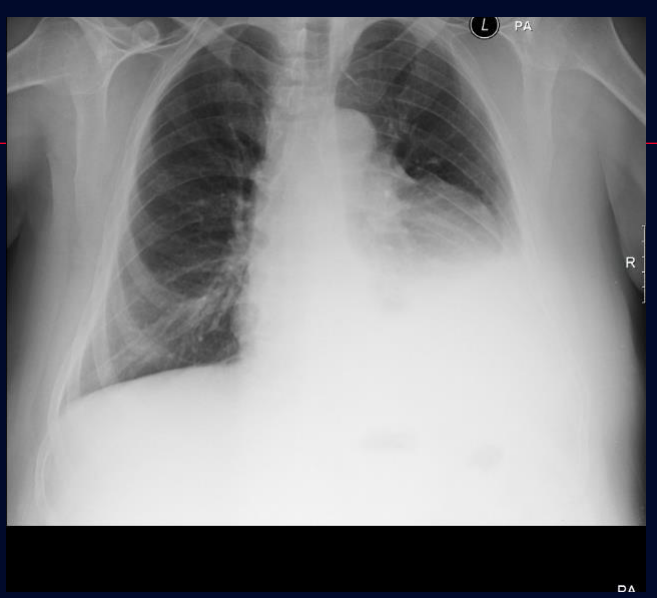

ACE
FPS: 61
f: 1.7 MHz/3.3 MHz
Soft
2
4
6
8
72
HR

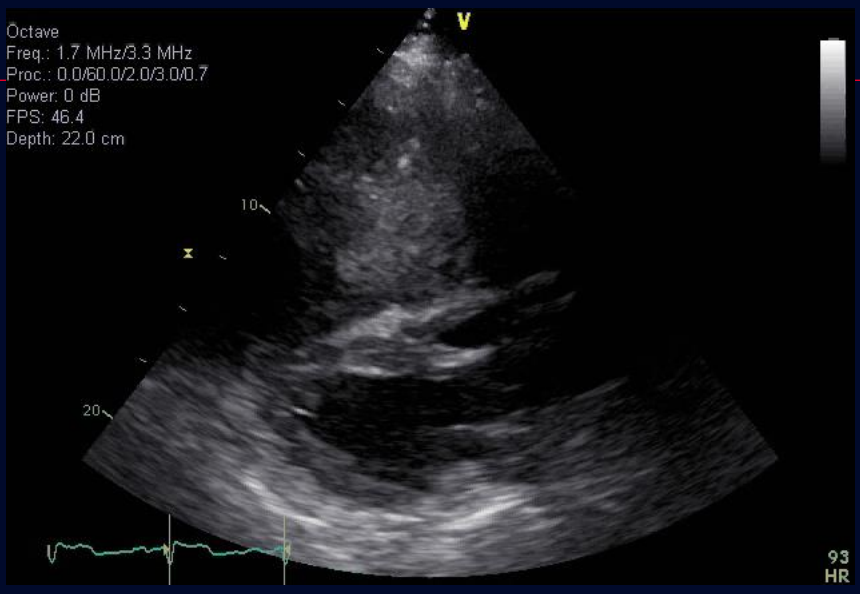

ACE
FPS: 24/24
f: 2.1 MHz/2.1 MHz
G(c): -5 dB
.64
-.64
5
10
62
HR

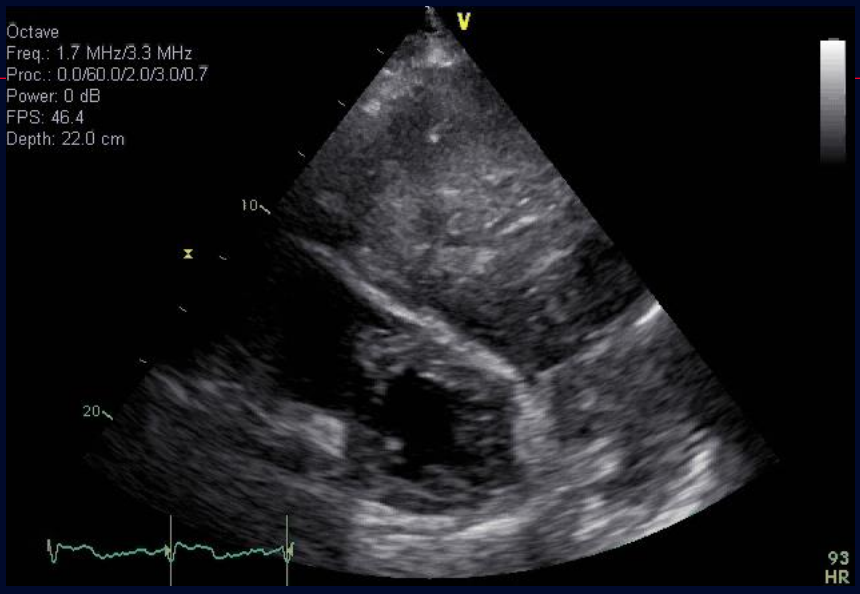


- Diagnosis
- Guidance of Pericardial drainage
- Guidance after new lead placed
- Guidance after perforated lead removed with surgical back up available

Extracardiac




Octave
Freq.: 1.7 MHz/3.3 MHz
Proc.: 0.0/60.0/2.0/3.0/0.7
Power: 0 dB
FPS: 46.4
Depth: 22.0 cm
V
10
20
93
HR


Octave
Freq.: 1.7 MHz/3.3 MHz
Proc.: 0.0/60.0/2.0/3.0/0.7
Power: 0 dB
FPS: 46.4
Depth: 22.0 cm
V
10
20
93
HR

The use of echocardiography in acute cardiovascular care: Recommendations of the European Association of Cardiovascular Imaging and the Acute Cardiovascular Care Association

- Echocardiography is one of the most powerful diagnostic and monitoring tools available to the modern emergency/ critical care practitioner
  - provision of echocardiography is fundamental to the management of patients with acute cardiovascular disease.
  - Echo can provide important information throughout the whole patient pathway, having been shown to change therapy in 60–80% of patients in the pre-hospital setting,
  - improve diagnostic accuracy and efficiency in the emergency room,
  - reveal the aetiology of unexplained hypotension in 48% of medical intensive care patients
  - Echocardiography is now included in the universal definition of acute myocardial infarction (AMI), and in international guidelines regarding the management of cardiac arrest.

Eur Heart J Cardiovasc Imaging. 2014;16(2):119-146European Heart Journal – Cardiovascular Imaging 2015, 16:119-46

Pulmonary Oedema & Pneumothorax

- Pulmonary Oedema
  - Accuracy approaches 100%
  - Characteristic lung rockets
  - Caused by intraalveolar oedema
- Pneumothorax
  - Absence pleural sliding
  - Barcode sign, absent waves on beach (m-mode)

From: The use of echocardiography in acute cardiovascular care: Recommendations of the European Association of Cardiovascular Imaging and the Acute Cardiovascular Care Association

Eur Heart J Cardiovasc Imaging. 2014;16(2):119-146. doi:10.1093/ehjci/jeu210