All About the Apex

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September 20. 2025

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Objectives

- Image acquisition – guidelines
- LV mechanics
- Discuss pathology impacting the LV apex
- Case study review
- Image optimization of various pathologies

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Ideal Apical Image Acquisition Window

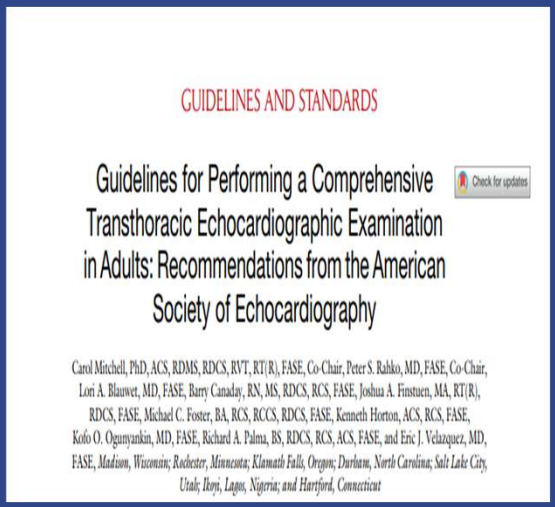
- 5th intercostal space
- Point of Maximum Impulse (PMI)
- Mid axillary line
- Specialized cut out bed
  - HOWEVER

    Changes in pathology

    lung artifact

    Rib spaces

    Thoracic cavity pathology



GUIDELINES AND STANDARDS

Guidelines for Performing a Comprehensive Transthoracic Echocardiographic Examination in Adults: Recommendations from the American Society of Echocardiography

Carol Mitchell, PhD, ACS, RDMS, RDCS, RVT, RT(R), FASE, Co-Chair, Peter S. Rahko, MD, FASE, Co-Chair, Lori A. Blauwet, MD, FASE, Barry Canaday, RN, MS, RDCS, RCS, FASE, Joshua A. Finstuen, MA, RT(R), RDCS, FASE, Michael C. Foster, BA, RCS, RCCS, RDCS, FASE, Kenneth Horton, ACS, RCS, FASE, Koto O. Ogunyankin, MD, FASE, Richard A. Palma, BS, RDCS, RCS, ACS, FASE, and Eric J. Velazquez, MD, FASE, *Madison, Wisconsin; Rochester, Minnesota; Klamath Falls, Oregon; Durham, North Carolina; Salt Lake City, Utah; Ilorin, Lagos, Nigeria; and Hartford, Connecticut*

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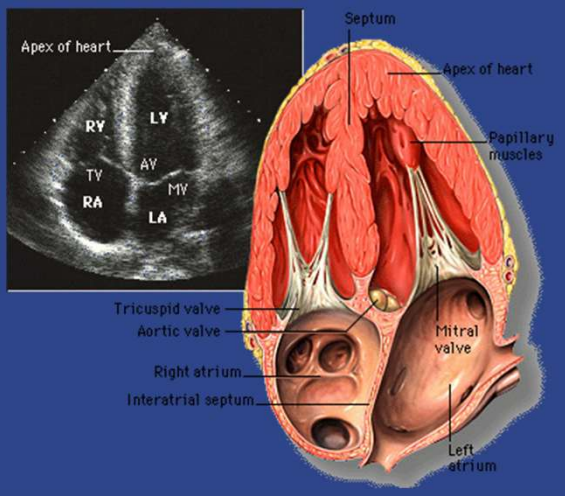
4CH view- normal heart

- All 4 chambers seen- sector wedge just wide enough to see all chambers, pericardium and a bit of surrounding tissue,
  - Best frame possible
- Left structures on right, right on left
- Apex top and center
- Full excursion an MV and TV leaflets
- Visualize from the base of left atrium to the apex of left ventricle - 2/3 ventricle, 1/3 atrium
  - Helpful to understand normal ratio so LV not being foreshortened
  - LV ellipsoid (bullet) shape at the apex- not round
- Walls and septa of each chamber visualized
- myocardium uniform from apex to atrioventricular valves



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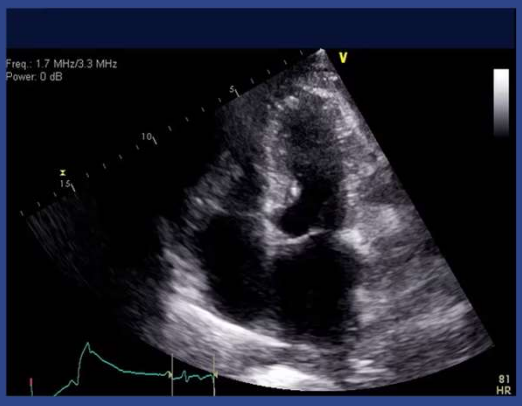
Foreshortening



Low and lateral-breath hold

Foreshortened

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Foreshortening

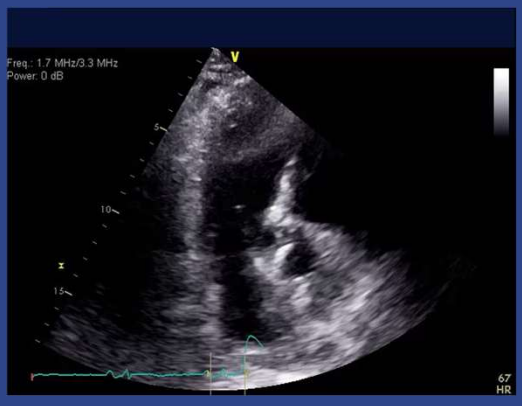
Low and lateral-breath hold

Foreshortened

7

Foreshortening

Low and lateral-breath hold



Foreshortened

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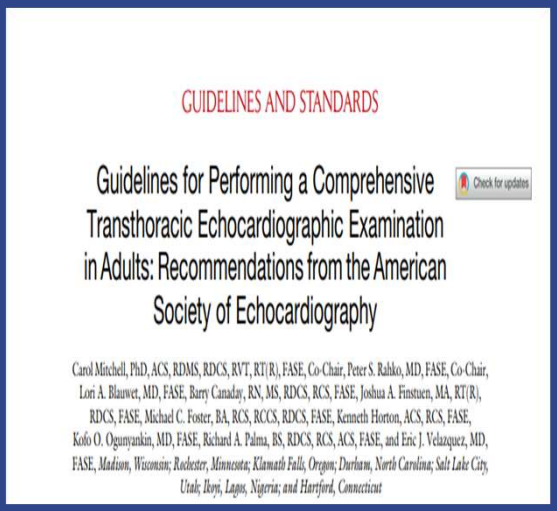
LV Measurements

- Interface between the compacted and non-compacted myocardium should be used for all 2D and 3D measurements.
  - Solid homogenous wall separate from trabeculations and papillary muscles.
  - Blood tissue interface



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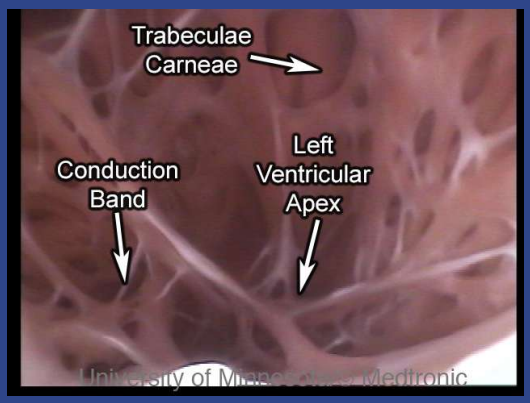

Left Ventricle Apex | Atlas of Human Cardiac Anatomy

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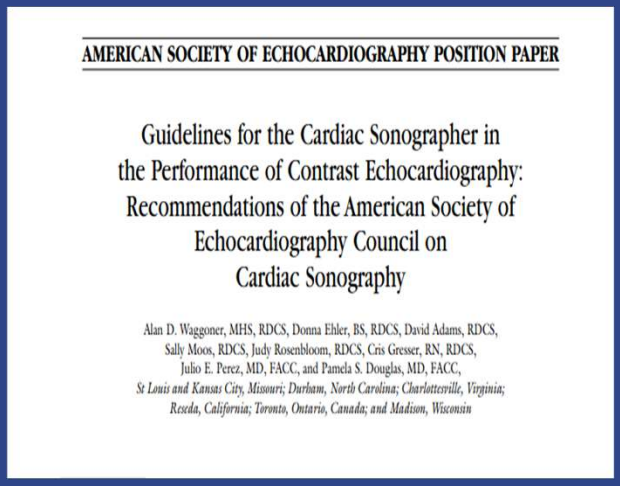
Contrast

- ASE Guidelines suggest 2 or more contiguous segments
- To opacify and delineate
- Sonographer driven
- Scope of practice
- Expectation for excellence



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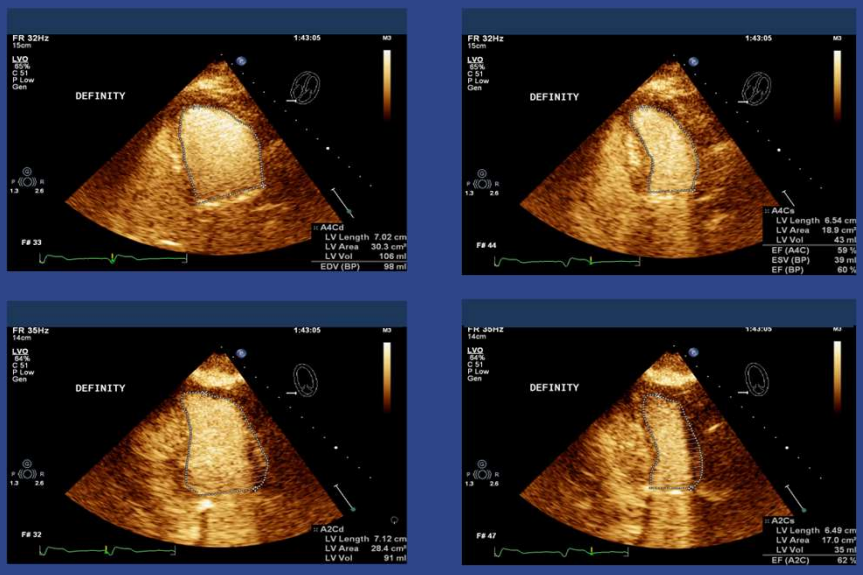

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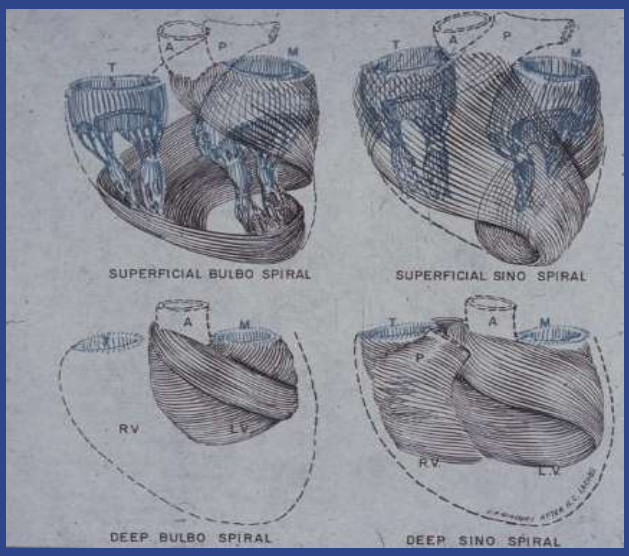
Cardiac muscle fibers

- Complex muscle fiber orientation
- Fibers run in many different directions
- Difficult to assess with Doppler based methods
- 2D and 3D wall motion tracking allows assessment of these complex fibers including
  - Rotation- degrees
  - Twist- difference between base and apex
  - Torsion- factors in shortening along the longitudinal plane
- We regularly use 2D strain imaging technology to track longitudinal fibers in the endocardium



Courtesy, J. Gorcsan MD

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LV mechanics

The apex rotates counterclockwise during systole

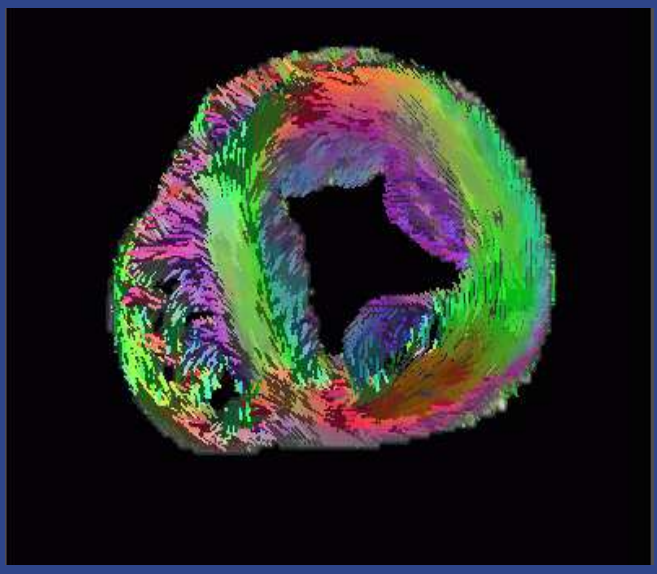
While the base rotates clockwise during systole

Much like wringing a towel

Twists during systole – aids in ejection

Untwists during diastole- aids in filling

Torsion is the shortening along the longitudinal fibers



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Apical Impact

- Apical Hypertrophic cardiomyopathy
- Apically displaced papillary muscle
- Non-compaction cardiomyopathy
- Thrombus
- Tumors
- Fabry's Disease)Anderson Fabry)
- Takotsubo Cardiomyopathy
- LVAD conduits
- Sarcoidosis
- Aneurysm
- Pseudo aneurysm
- Hemochromatosis
- Hyperesinophilia Syndrome
- Foreign objects

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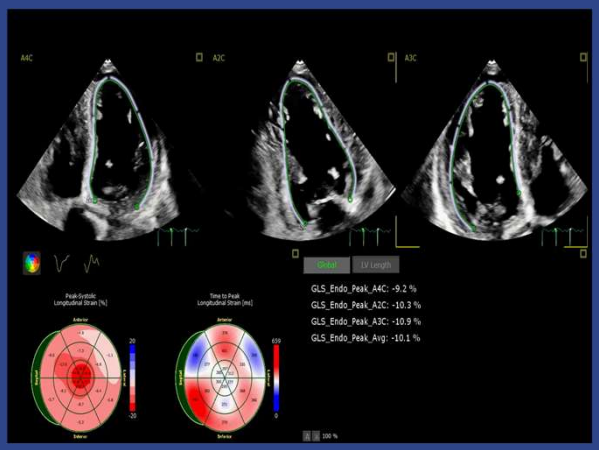
Amyloidosis-very distinct stain profile

- Rare disease occurs when the amyloid protein builds up in the cardiac muscle-among other organs
- Symptoms are much like many other cardiac diseases- HFpEF
- Drug therapies

Strain imaging



Mayoclinic.org

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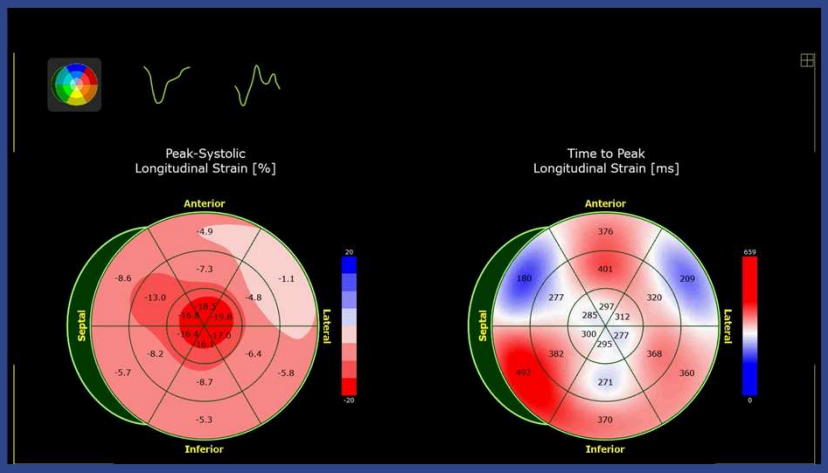
Amyloidosis- Cherry on Top



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Apical Hypertrophic Cardiomyopathy

- Less known variant- but not as rare as first thought
- Fewer have family history compared with classic HCM-risk stratification difficult
- Generally non obstructive
- 25% in Asian and 1-10% in non- Asian populations-western suffers more malignant form
- More A-fib and sudden cardiac arrhythmias
- More sudden death if apical aneurysm (diverticulum) is present
- Sarcomere mutations are detected less frequently

Ahajournals.org

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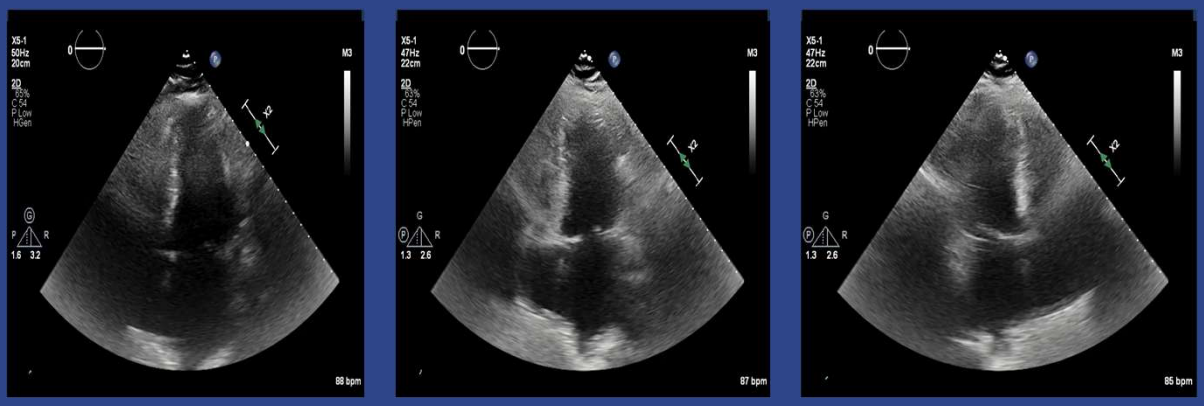
Apical hypertrophic cardiomyopathy



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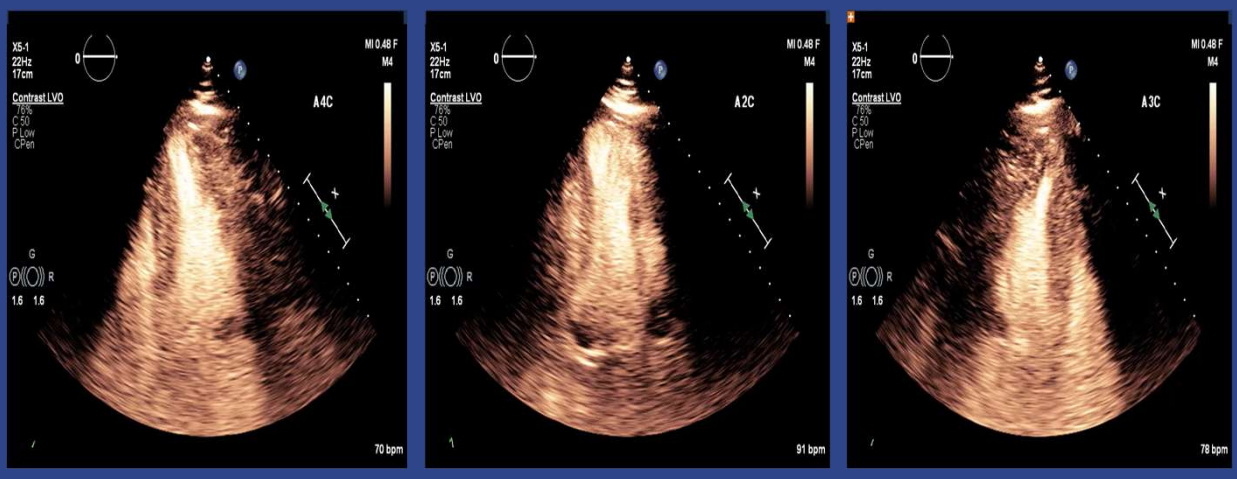
Apical Hypertrophic Cardiomyopathy



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Apical Hypertrophic Cardiomyopathy

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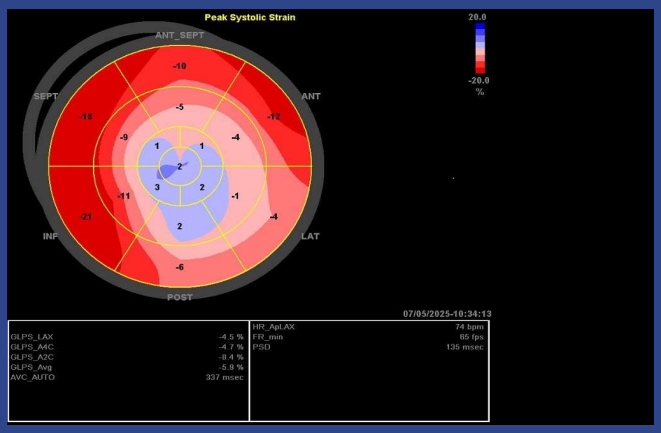
Apical HCM- Blueberry on Top



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Apically Displace Papillary Muscle

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Non-compaction Cardiomyopathy

CM in which the two myocardial layers do not compact
- Thin compacted myocardial layer
- Thick spongy heavily trabeculated layer

Rare – 0.014- 0.26% 2x more common in men

May be found in utero up through adulthood-most common in children

Genetic

May be biventricular

Can be associated with neuromuscular or chromosomal disorders, and congenital defects such as ASD, PS, Bicuspid AV, and Ebstein's anomaly

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Non-compaction Cardiomyopathy

May impact athletes, pregnancy or sickle cell patients due to increased Preload, different mechanism- reversable

Isolated- some people have sporadic LVNC with no family history and no proven genetic mutation

- Asymptomatic

15-20% inherited and present earlier than non inherited

Up to 50% of LVNC cases have a 1st degree relative with some form or cardiomyopathy

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Noncompaction Cardiomyopathy

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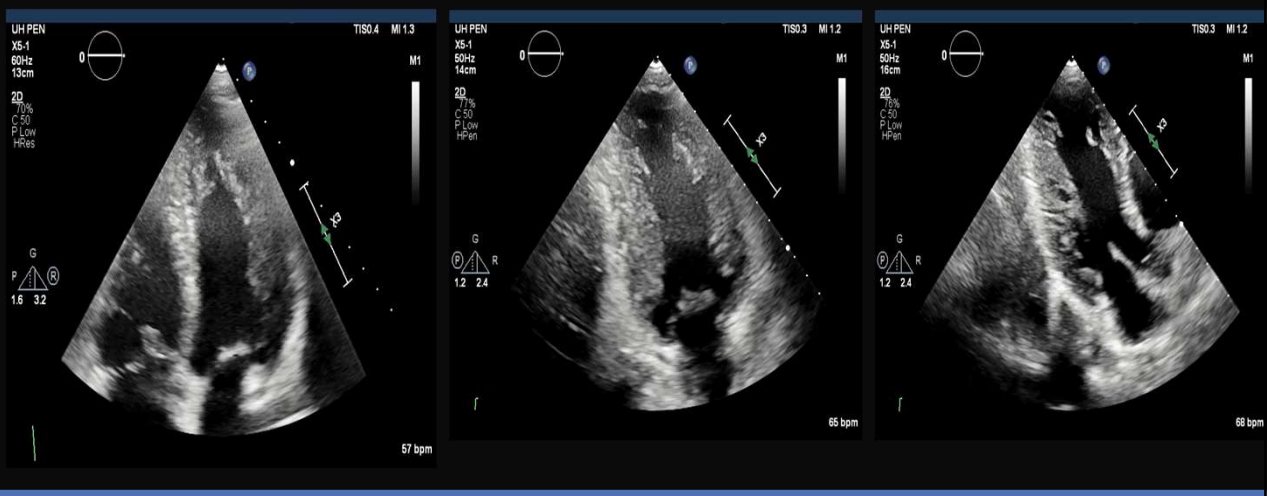
Noncompaction Cardiomyopathy



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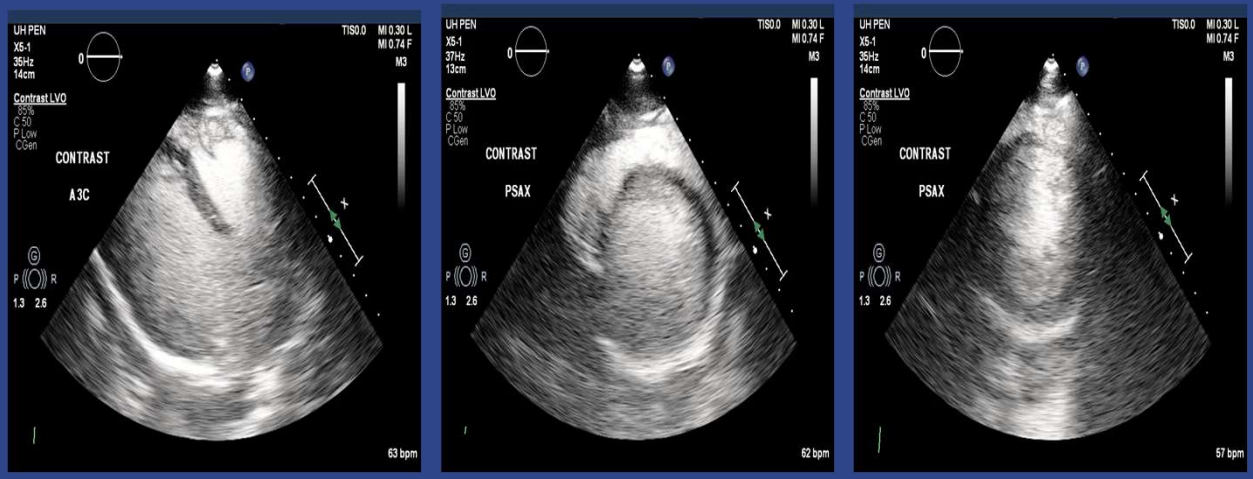
Non-compaction Enhancement



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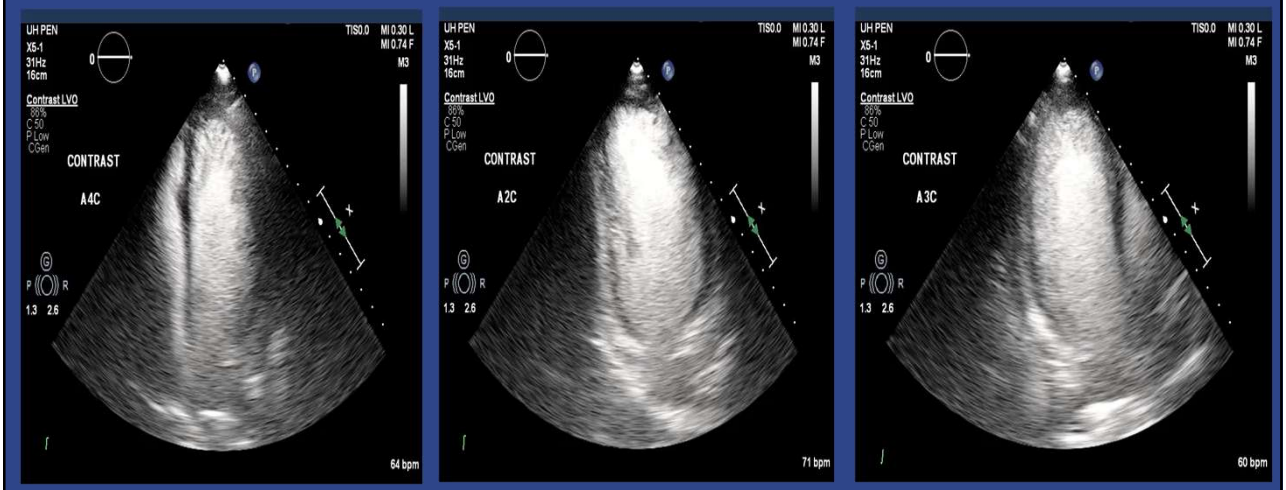
Non-compaction Enhancement



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Noncompaction Risks and Treatment

Arrhythmias A-fib
Antiarrhythmic medications

Thrombus
Anticoagulants

Heart failure.
Medications and PPM/AICD

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Thrombus

- Potential complication of both ischemic and non ischemic cardiomyopathies
- STEMI is more likely than NSTEMI
- LAD / anterior MI's are the most common to form apical thrombus
- Incedence of post infarct thrombus has improved d/t improved earlier intervention / reperfusion techniques.
- Increase incidence of embolic events and potential death
- Cardiac MR is the most accurate for diagnosis followed by echo with contrast
  - Contrast echo nearly double sensitivity from 33% to 61%
  - Increases accuracy from 82%- 92% vs non contrast echo.

https://pmc.ncbi.nlm.nih.gov/articles/PMC8039643/

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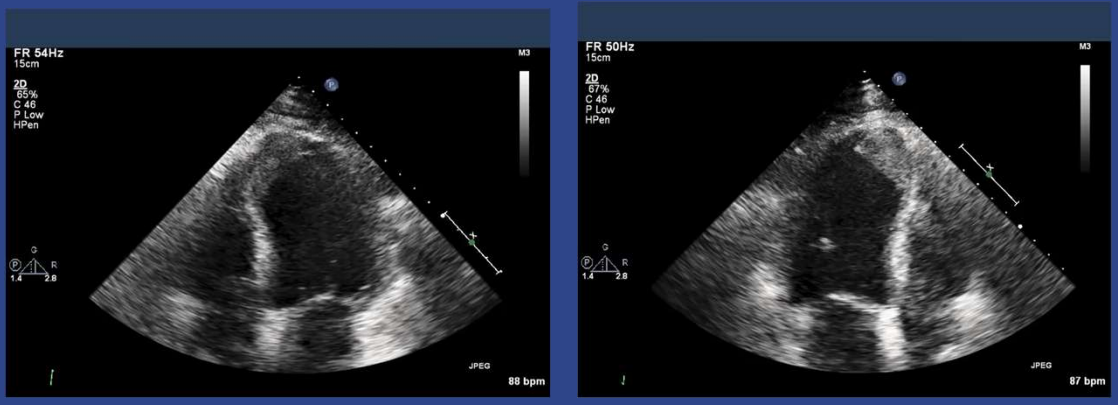
Thrombus



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Fresh Thrombus

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Fresh Thrombus

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Cardiac Tumors

Primary- rare 0.001-0.03 % autopsy series

Benign- 75%

- Myxoma (50%), lipoma, and papillary fibroelastoma (cardiac valves),fibroma(muscle)

Malignant 25%

- Sarcoma-angio, rhabdomyo, leiomyo, lipo, osteo, fibro, and fibrous histio sarcoma (Rt. Heart and atria)

https://pmc.ncbi.nlm.nih.gov/articles/PMC3195386/

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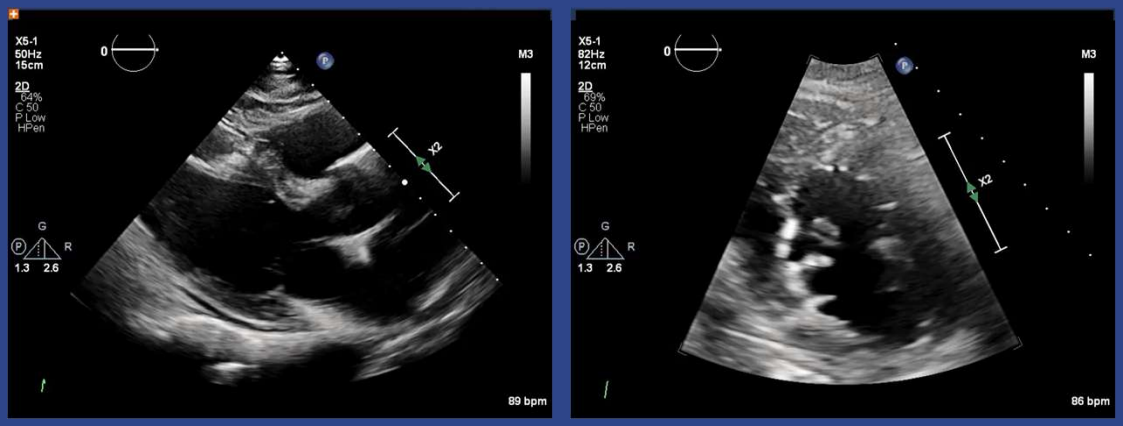
Primary Tumor



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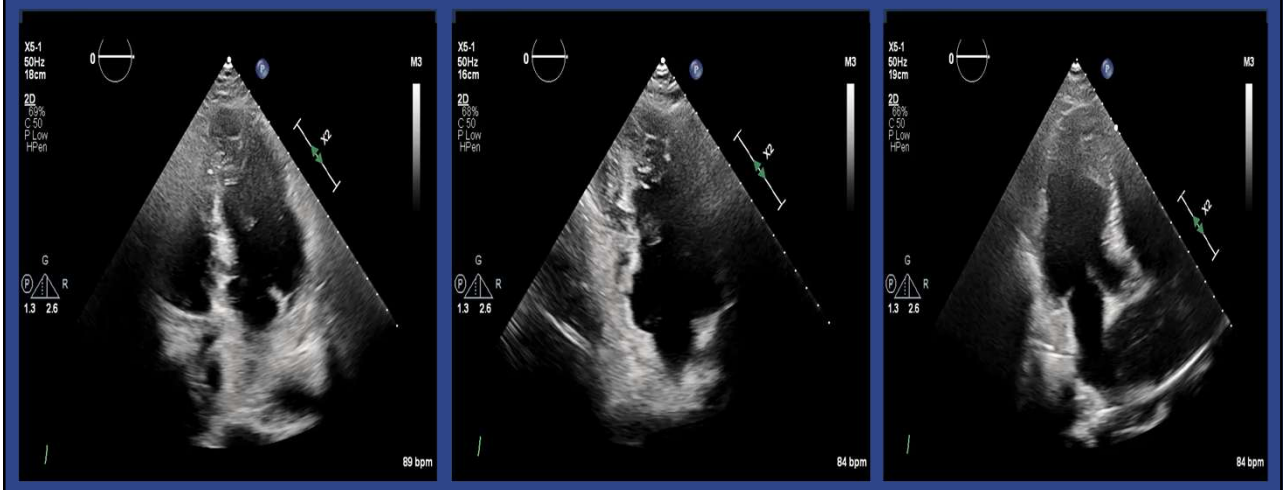
Primary Tumor



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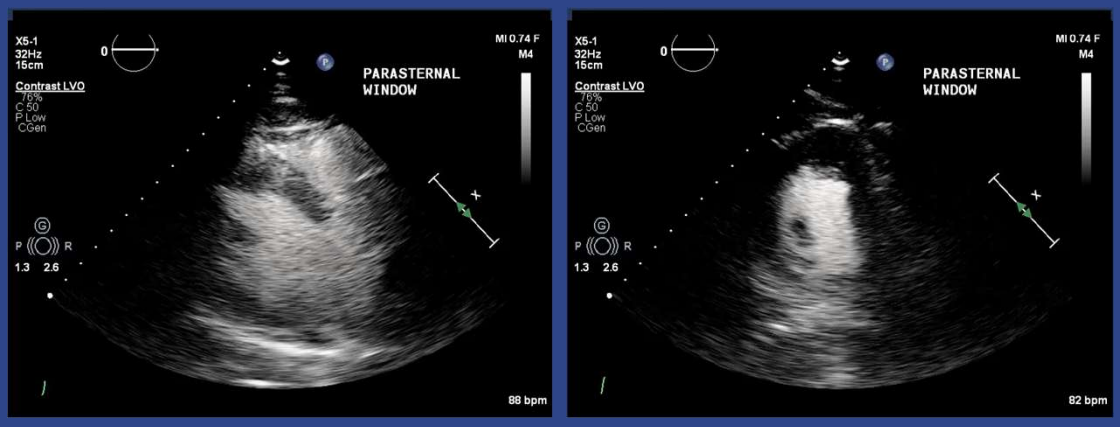
Primary Tumor



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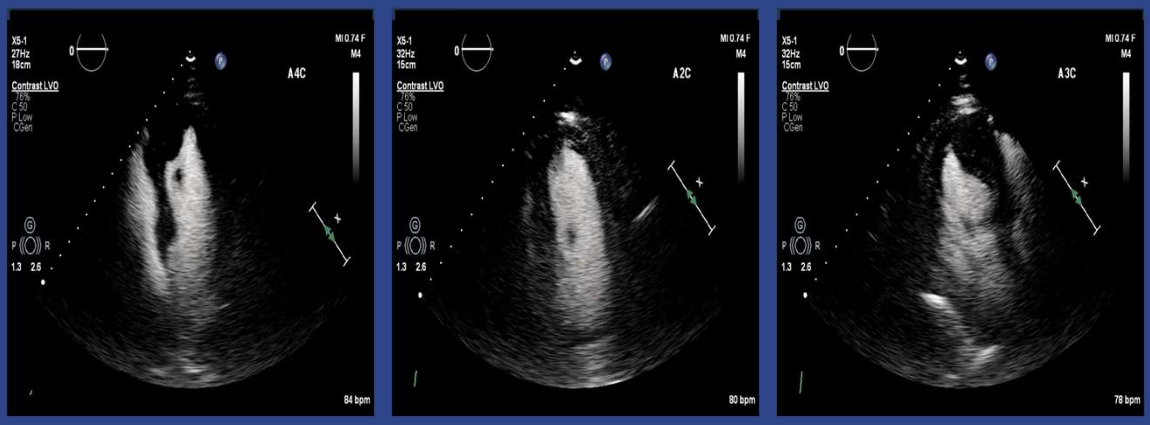
Primary Tumor



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Secondary (metastatic) Cardiac Tumors

- 30 – 40 x more common than primary tumors
- 15% of cancer patients w/ metastatic cancer will exhibit cardiac metastasis
  - Melanomas, lung, breast, renal and lymphoma
- TTE, TEE, 3D and contrast echocardiography, Cardiac MRI, CT and PET scan help diagnose
  - Echo 90 % sensitivity -95% specificity
- Surgery and histological examination
  - Cardiac biopsy, pericardial or pleural fluid cytology
- Direct extension of tumors, blood and IVC or SVC propagation
  - Pericardium most often site

https://pmc.ncbi.nlm.nih.gov/articles/PMC3195386/

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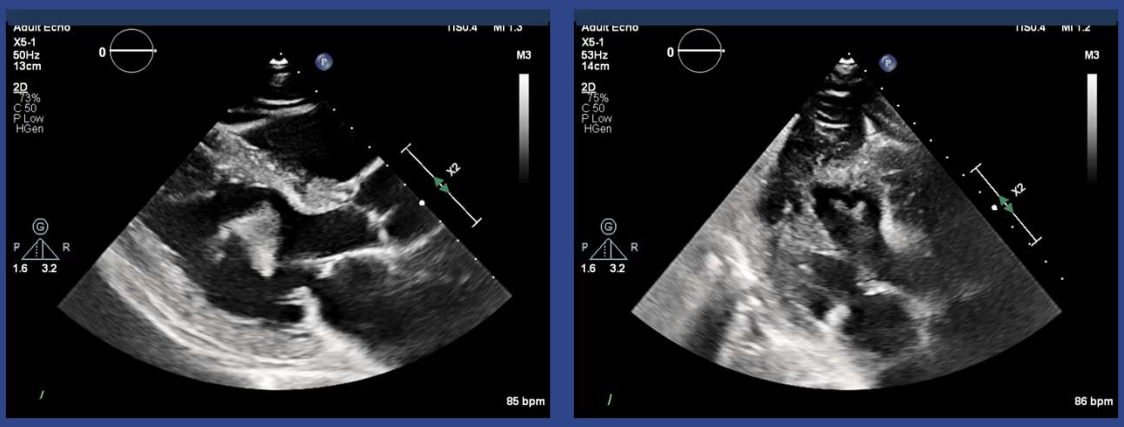
Secondary Metastatic Tumor



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Secondary Metastatic Tumor

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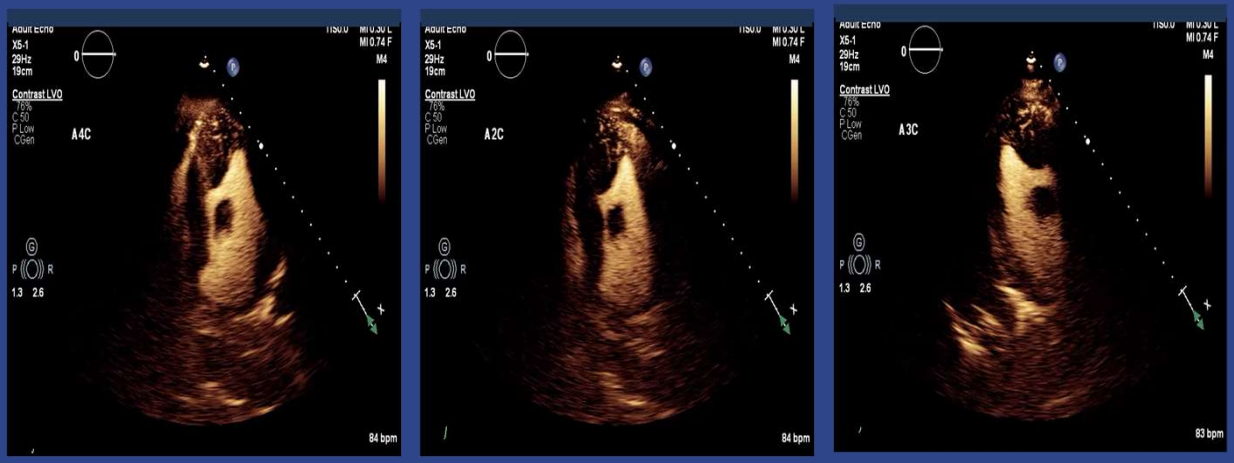
Secondary Metastatic Tumor



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Anderson-Fabry's Disease

Genetic lysosomal storage disorder in which enzymes responsible for breaking down lipids do not function properly

fat like substances build up in blood vessels and tissues and impact heart, brain, kidneys, central nervous system and skin

2 types

Classic- childhood by age 2 up teenage

Late onset-atypical, 30's or older

- Presents as kidney and or heart failure

Predominantly men. 1 in 1500-4000

Unknown data on women as they are primarily asymptomatic

https://my.clevelanclinic.org/health/diseases/16235-fabry-disease

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Anderson-Fabry's Disease

- Numbness- hands and feet
- Excessive pain during physical activity
- Heat and Cold intolerance
- Dizziness
- Fatigue
- Edema
- Flu like symptoms

https://my.clevelanclinic.org/health/diseases/16235-fabry-disease

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Anderson-Fabry's Disease

- Kidney failure
- Heart failure
- Peripheral neuropathy
- TIA's and CVA's
- Cardiac arrythmias
- Myocardial infarction
- Cardiomegaly

https://my.clevelanclinic.org/health/diseases/16235-fabry-disease

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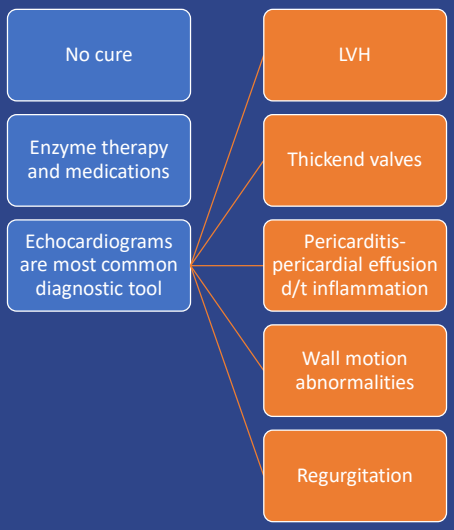
Management and treatment



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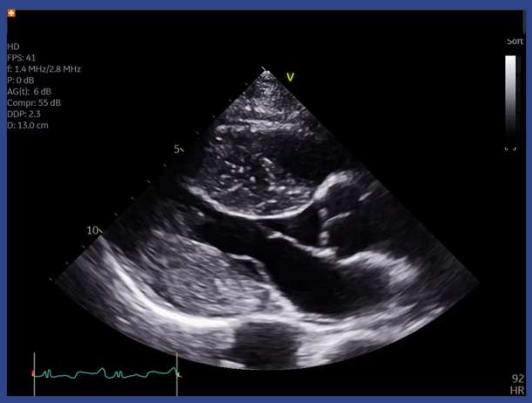
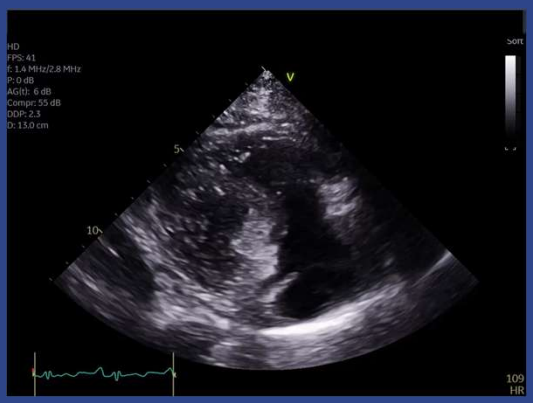
Fabry's



Significant LVH



Significant RVH

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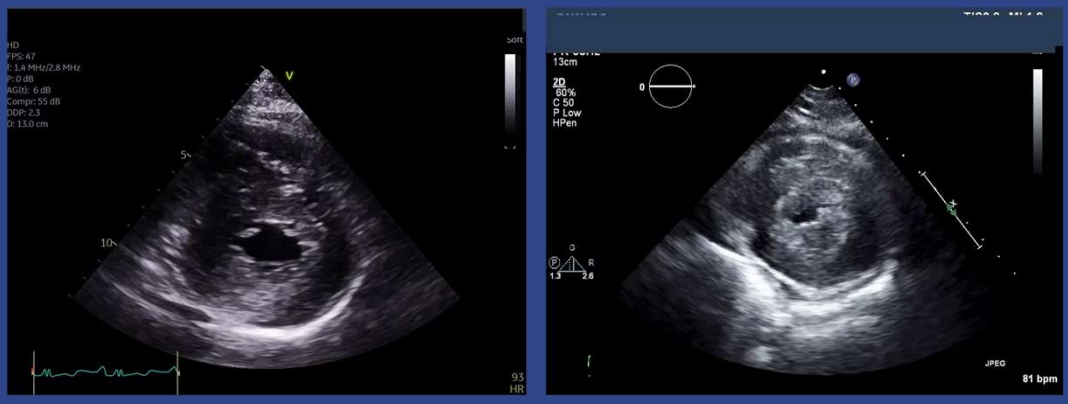
Fabry's



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Fabry's

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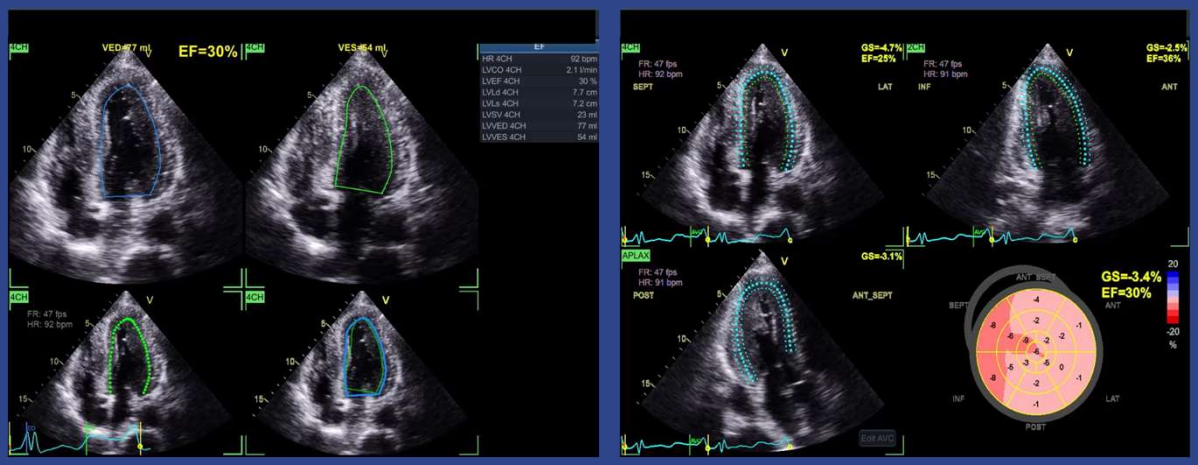
Fabry's



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St Louis and Kansas City, Missouri; Durham, North Carolina; Charlottesville, Virginia; Reseda, California; Toronto, Ontario, Canada; and Madison, Wisconsin

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Takotsubo Cardiomyopathy

- Syndrome of transient systolic dysfunction of the apex in 82% of cases
  - May be mid or basal
- This mimics MI in the absence of obstructive CAD.
- Other names include apical ballooning syndrome, stress induced cardiomyopathy or broken heart syndrome.
- First described in Japan (Sato et al, 1990) now reported worldwide

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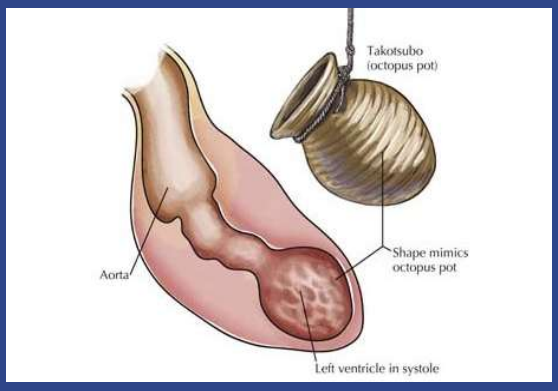
Takotsubo Cardiomyopathy



Octopus pot

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Takotsubo Cardiomyopathy

- Accounts for 1.7 % to 2.2 % of all cases presenting with suspected ACS.
- predominately women (88.8%)[1]
- Mean age 61-75 years.[2]
- Chest pain most common symptom(50-60 %) followed by dyspnea.
- Syncope and cardiac arrest are rare.
- Intensive care patients more likely to present with pulmonary edema, ischemic ECG changes, or elevated biomarkers. (Troponins may be elevated but not extremely.)
- Hemodynamic compromise is unusual, but hypotension can occur due to reduced stroke volume and dynamic left ventricular outflow obstruction

1. Gianni et al Eur Heart J 2006
2. Akashi et al Circulation 2005

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Emotional or Physical Stress

30% emotional stress

41% Physical stress

29% no identifiable stressors

PUBLIC SPEAKING

Table 2. Preceding Stressful Events

Events	No. (%) of Participants
Emotional stressors	77 (30)
Death of a relative/friend/pet	20
Interpersonal conflict	15
Panic/fear/anxiety	10
Anger/frustration	6
Job problems	5
Severe disease of a relative/friend	4
Diagnosis of malignancy	4
Bad news	3
Other	10
Physical stressors	105 (41)
Perisurgical or postsurgical	23
Acute respiratory failure (eg, chronic obstructive pulmonary disease, asthma bronchiale)	19
Malignancy/chemotherapy	8
Abdominal pain/gastric ulcera/diverticulitis	8
Infection	6
Stroke	4
Administration of exogenous catecholamines	4
Allergic drug/vaccination reaction	3
Colonoscopy	2
Seizure	2
Fall	2
Other	24
No identifiable stressors	74 (29)

Eitel et al JAMA 2011

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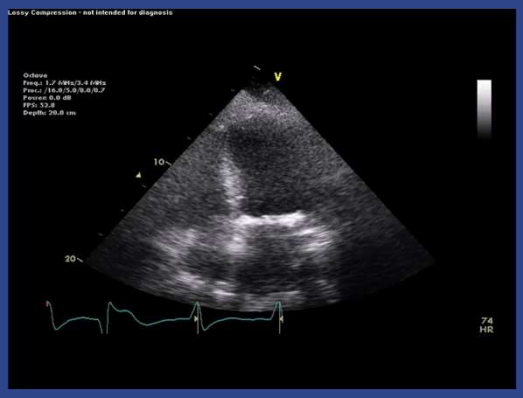
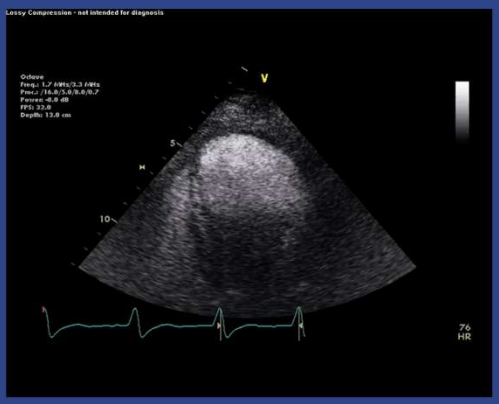
ICU Echo done 2/2015

4CH



4CH Definity



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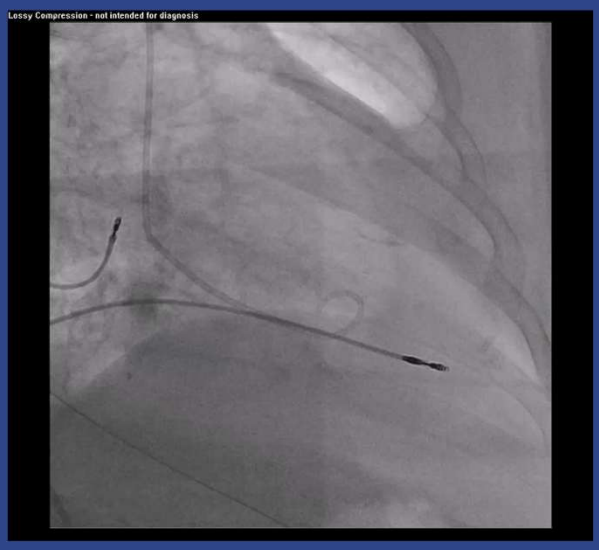
Cardiac catheterization



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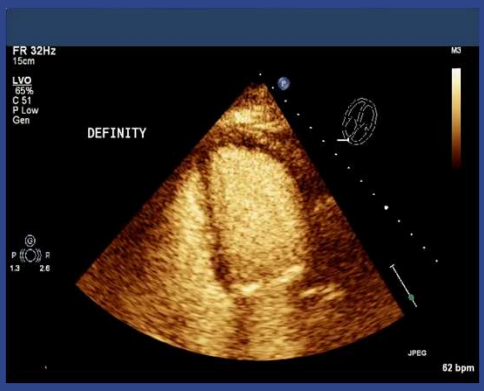
Echo done 4/2015

4CH

Definity 4CH



Recovered 60%- Patient was doing well

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Takotsubo CM

- Usually resolves in 1-4 weeks
- Fully resolves in 2 months
- Death rare, heart failure 20%
- Complications
  - Arrhythmias
  - LVOT obstruction
  - LV rupture

https://www.health.harvard.edu/heart-health/takotsubo-cardiomyopathy-broken-heart-syndrome

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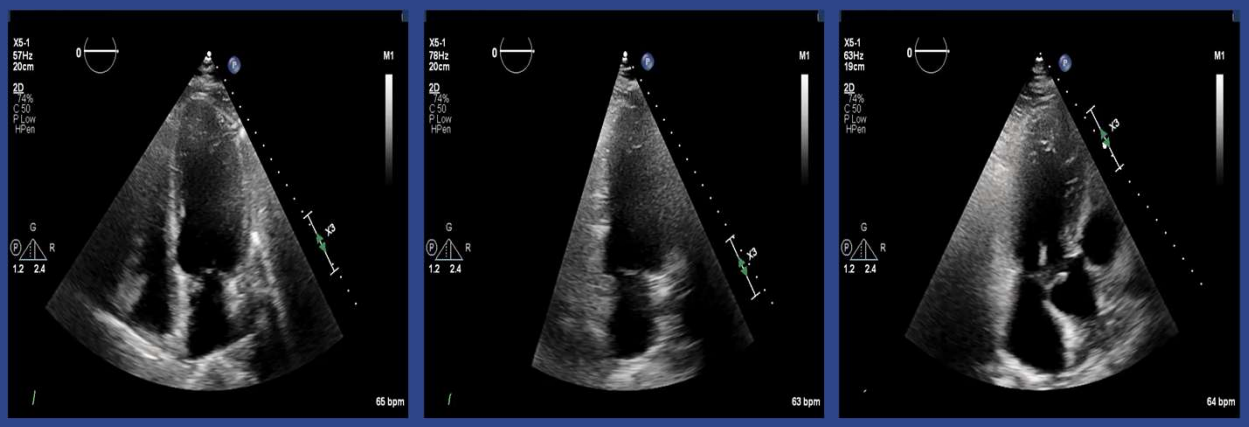
Aneurysm



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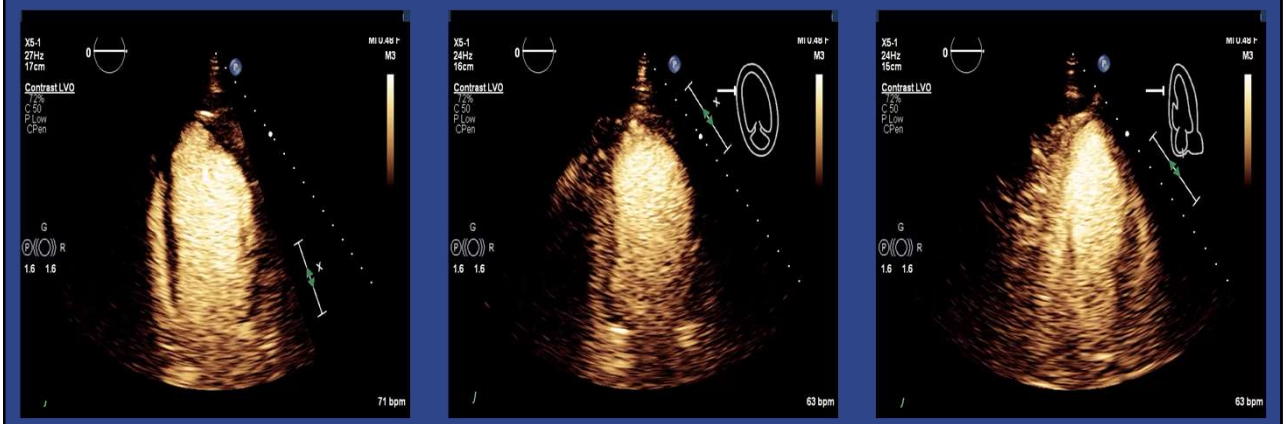
Aneurysm Contrast



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