MYOCARDIAL DISEASE, CARDIOMYOPATHY Moderators: *B. Khandheria, S. Little*	
2:00 PM	**Hypertrophic Cardiomyopathy: State-of-the-Art 2018** *B. Khandheria*
2:20 PM	**Variants of Hypertrophic Cardiomyopathy: Lateral Wall, Hypertrophy Papillary Muscle, Mid Ventricular** *S. Lester*
2:40 PM	**Case Studies: Thick Walls, Is this Hypertrophic Cardiomyopathy?** *M. Umland*
3:00 PM	**Case Studies: Athlete's Heart** *R. Lang*
3:20 PM	**Case Studies in Systemic Illness and the Heart: Sarcoid, Hemachromatosis, Hypereosinophilia** *M. Saric*
3:40 PM	**Right Ventricular Dysplasia, Right Ventricular Hypertrophy Due To Pulmonary Hypertension** *S. Little*
4:00 PM	**Common Adult Congenital Heart Disease: Atrial Septal Defect, Ventricular Septal Defect, Ebstein** *M. Saric*
4:30 PM	**Question and Answer**

31st Annual State of the Art Echocardiography | San Diego, CA

February 19, 2018 | 3:20 – 3:40 PM | 20 min

Heart in Systemic Disease: Sarcoid, Hemochromatosis, Hypereosinophilia

Muhamed Sarić MD, PhD, MPA
Director of Noninvasive Cardiology | Echo Lab
Associate Professor of Medicine

NYU Langone MEDICAL CENTER

Disclosures

Speakers Bureau (Philips, Medtronic)
Advisory Board (Siemens)

CARDIOMYOPATHY

καρδιο-μυο-πάθεια = 'disease of the myocardium'

Any disease of the myocardium
that cannot be explained by
(1) ***coronary artery narrowing*** *or*
(2) ***abnormal loading of the ventricles.***

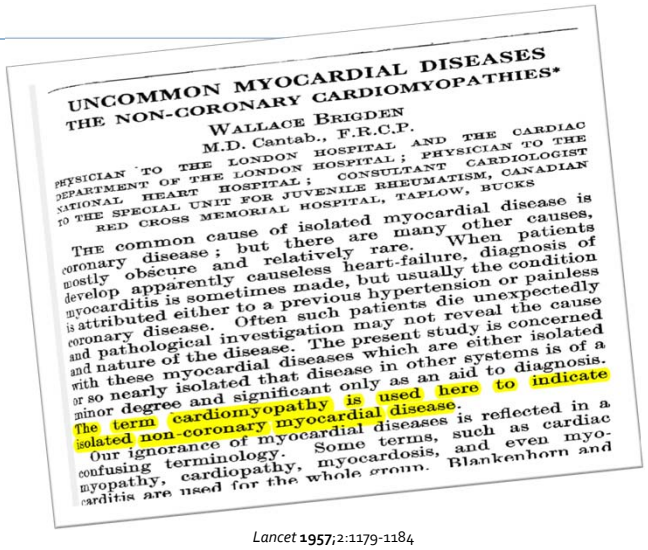
J Am Coll Cardiol. **2013;**62(22):2073-4.

And there is a very large number
of such diseases of the myocardium…

CARDIOMYOPATHY

*Term was first used in **1956** in a lecture by Brigden, which was then published in Lancet in 1957.*

Wallace Brigden
(1916 – 2008)
English cardiologist



UNCOMMON MYOCARDIAL DISEASES
THE NON-CORONARY CARDIOMYOPATHIES*

WALLACE BRIGDEN
M.D. Cantab., F.R.C.P.

PHYSICIAN TO THE LONDON HOSPITAL AND THE CARDIAC DEPARTMENT OF THE LONDON HOSPITAL; PHYSICIAN TO THE NATIONAL HEART HOSPITAL; CONSULTANT CARDIOLOGIST TO THE SPECIAL UNIT FOR JUVENILE RHEUMATISM, CANADIAN RED CROSS MEMORIAL HOSPITAL, TAPLOW, BUCKS

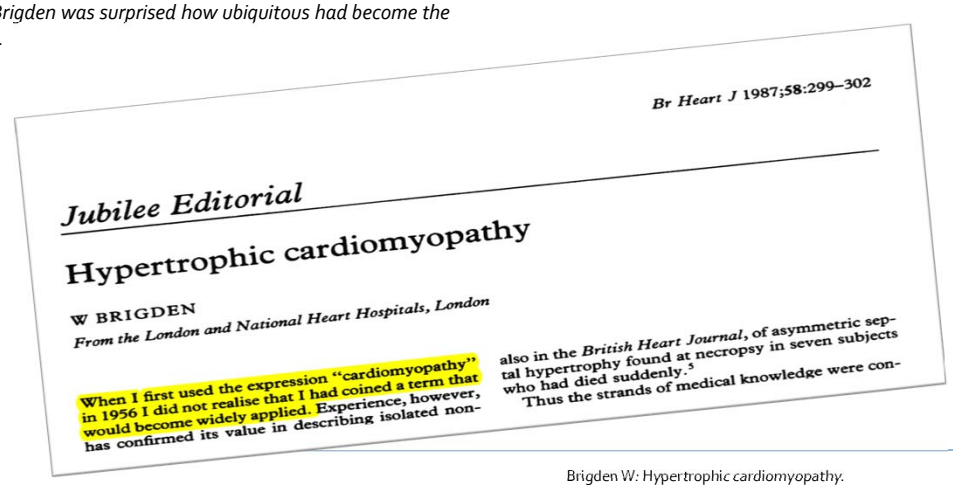
THE common cause of isolated myocardial disease is coronary disease; but there are many other causes, mostly obscure and relatively rare. When patients develop apparently causeless heart-failure, diagnosis of myocarditis is sometimes made, but usually the condition is attributed either to a previous hypertension or painless coronary disease. Often such patients die unexpectedly and pathological investigation may not reveal the cause and nature of the disease. The present study is concerned with these myocardial diseases which are either isolated or so nearly isolated that disease in other systems is of a minor degree and significant only as an aid to diagnosis. The term cardiomyopathy is used here to indicate isolated non-coronary myocardial disease.

Our ignorance of myocardial diseases is reflected in a confusing terminology. Some terms, such as cardiac myopathy, cardiopathy, myocardosis, and even myocarditis are used for the whole group. Blankenhorn and

Lancet **1957**;2:1179-1184

CARDIOMYOPATHY

Thirty years later, Brigden was surprised how ubiquitous had become the term he had coined.



Br Heart J 1987;58:299–302

Jubilee Editorial

Hypertrophic cardiomyopathy

W BRIGDEN

From the London and National Heart Hospitals, London

When I first used the expression "cardiomyopathy" in 1956 I did not realise that I had coined a term that would become widely applied. Experience, however, has confirmed its value in describing isolated non-

also in the *British Heart Journal*, of asymmetric septal hypertrophy found at necropsy in seven subjects who had died suddenly.[5] Thus the strands of medical knowledge were con-

Brigden W: Hypertrophic cardiomyopathy.
Br Heart J **1987**;58:299-302

CARDIOMYOPATHY

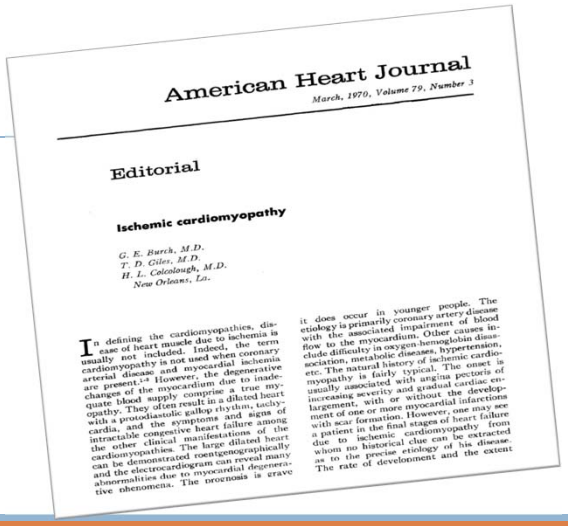
Myocardial disease that is **not**
ischemic, hypertensive or related to valvular disease.

Yet…

There is a widespread use of terms
'**ischemic cardiomyopathy**' or even 'hypertensive cardiomyopathy'.

*The term '**ischemic cardiomyopathy**' was first coined in 1970.*

Am Heart J **1970**;79:291–2.



American Heart Journal
March, 1970, Volume 79, Number 3

Editorial

Ischemic cardiomyopathy

G. E. Burch, M.D.
T. D. Giles, M.D.
H. L. Colcolough, M.D.
New Orleans, La.

In defining the cardiomyopathies, disease of heart muscle due to ischemia is usually not included. Indeed, the term cardiomyopathy is not used when coronary arterial disease and myocardial ischemia are present.[1-3] However, the degenerative changes of the myocardium due to inadequate blood supply comprise a true myopathy. They often result in a dilated heart with a protodiastolic gallop rhythm, tachycardia, and the symptoms and signs of intractable congestive heart failure among the other clinical manifestations of the cardiomyopathies. The large dilated heart can be demonstrated roentgenographically and the electrocardiogram can reveal many abnormalities due to myocardial degenerative phenomena. The prognosis is grave it does occur in younger people. The etiology is primarily coronary artery disease with the associated impairment of blood flow to the myocardium. Other causes include difficulty in oxygen-hemoglobin dissociation, metabolic diseases, hypertension, etc. The natural history of ischemic cardiomyopathy is fairly typical. The onset is usually associated with angina pectoris of increasing severity and gradual cardiac enlargement, with or without the development of one or more myocardial infarctions with scar formation. However, one may see a patient in the final stages of heart failure due to ischemic cardiomyopathy from whom no historical clue can be extracted as to the precise etiology of his disease. The rate of development and the extent

CARDIOMYOPATHY CLASSIFICATIONS

2006
American
Heart Association Classification

Circulation
2006;113:1807-1816

2008
European
Society of Cardiology
Classification

Eur Heart J
2008;29:270–276

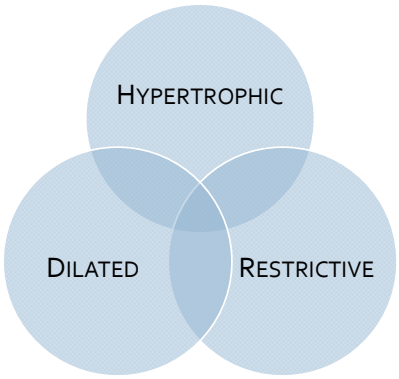
2013
MOGES
Classification

J Am Coll Cardiol
2013;62(22):2046-72

M - Morphology
O - Organ involvement
G - Genetics
E - Etiology
S - Status, clinical

CARDIOMYOPATHY CLASSIFICATIONS

All 3 classification systems **move away** from
the classic trilateral subdivision of cardiomyopathies.



SELECTED CARDIOMYOPATHIES

Chamber morphology vs. inheritance matrix

	'HYPERTROPHIC'		DILATED	MISC (Peculiar morphology)
	True Hypertrophy	Storage Disorder		
FAMILIAL	• HCM / HOCM • Fabry's disease • Carnitine deficiency	• ATTR amyloidosis • Hemochromatosis • Hunter's disease	• Idiopathic DCM	• ARVD • Noncompaction
NON-FAMILIAL	• Athlete's heart	• AL amyloidosis	• Peripartum • Ethanol abuse	• Takotsubo • Loeffler's

WHEN A CARDIOMYOPATHY SHOULD BE SUSPECTED?

Whenever there is inappropriate ventricular
'**hypertrophy**' or '**dilatation**'
(an increase in wall thickness or chamber size)
unexplained by coronary, hypertensive or valvular disease.

* * *

... especially when there is a **family history**
of a similar disorder

* * *

... or when the ventricle has
a **peculiar morphology** or **motion**.

CARDIOMYOPATHIES
where echocardiography
is diagnostic or nearly diagnostic.

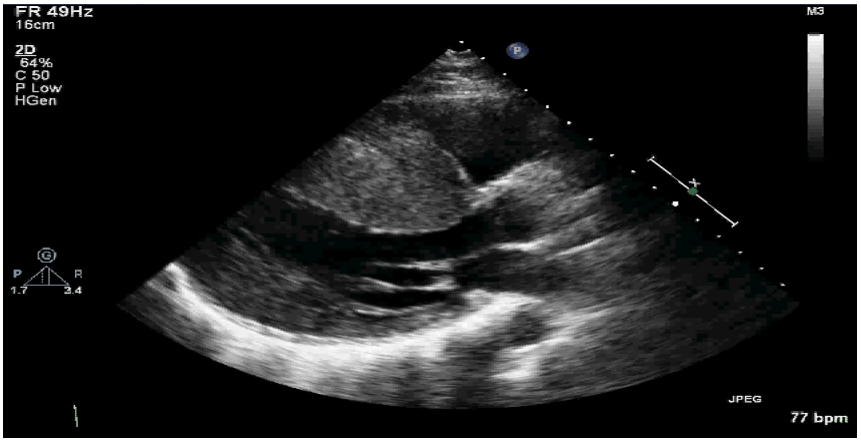
CARDIOMYOPATHIES
where echocardiography
is NOT diagnostic.

Clinical context, family history and other testing modalities are required to establish the diagnosis.

A Cardiomyopathy with Pathognomonic Appearance

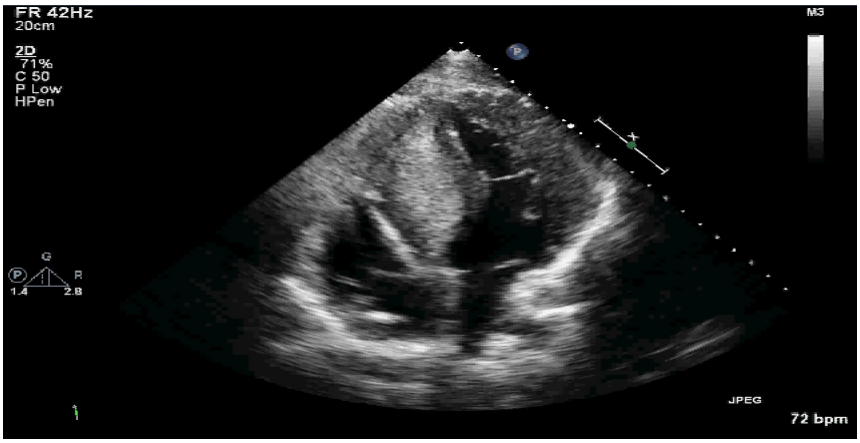
23-year-old male graduate student

- Enlarged heart since childhood
- NYHA class II
- Recent episode of ventricular fibrillation



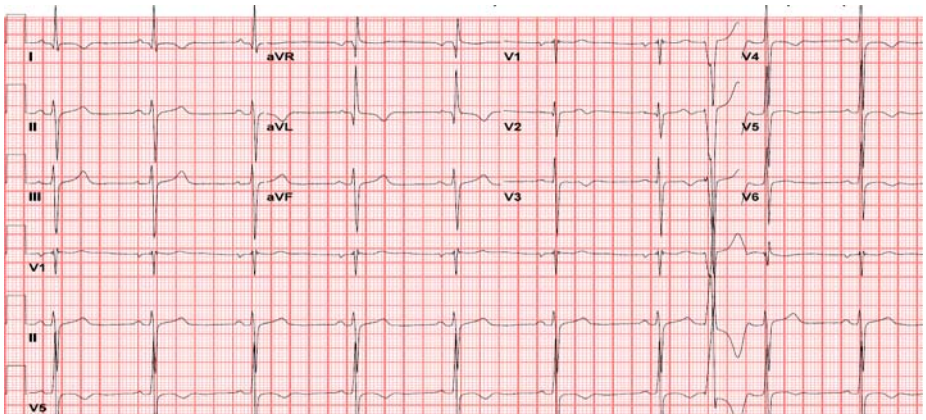
23-year-old male graduate student

- Diagnosed with HCM at age 12 by echo
- β Myosin heavy chain mutation
- ICD placed at age 15



23-year-old male graduate student

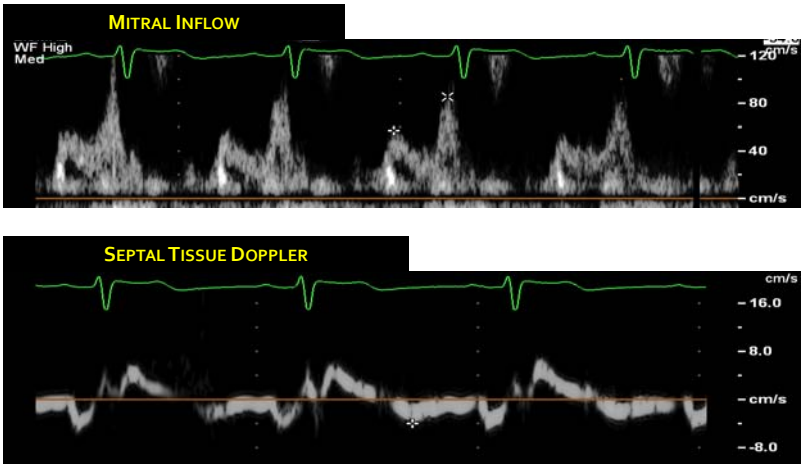
- Massive increase in LV wall thickness



EKG
Left ventricular hypertrophy

23-year-old male graduate student

- NYHA class II

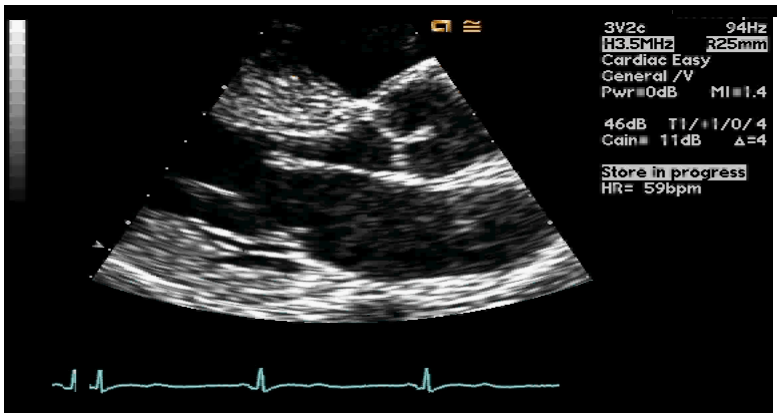


SPECTRAL DOPPLER
Grade I Diastolic Dysfunction

CONCLUSION

Hypertrophic Nonobstructive Cardiomyopathy

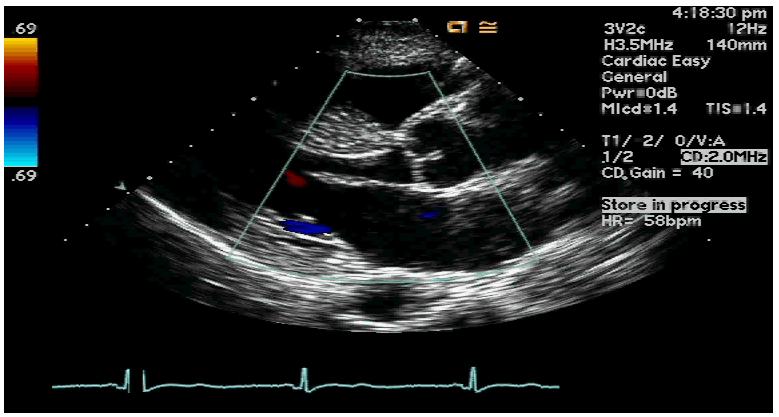
46-year-old man



TTE | PARASTERNAL LONG-AXIS VIEW
Systolic anterior motion (SAM) of the mitral valve

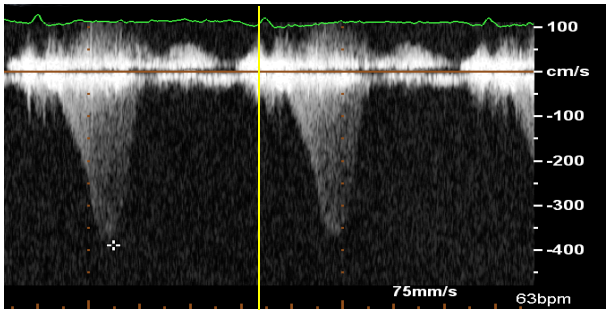
46-year-old man

- Family history of sudden death

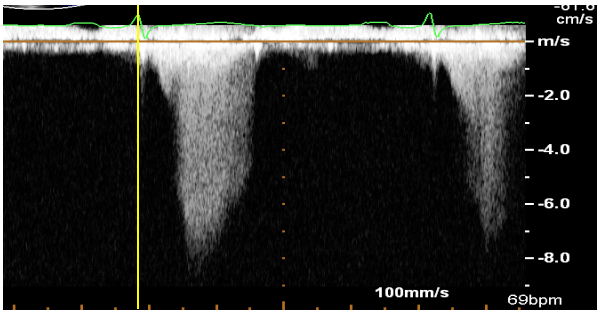


TTE | COLOR DOPPLER
LVOT obstruction +
Late systolic mitral regurgitation

HOCM: Spectral Doppler Patterns

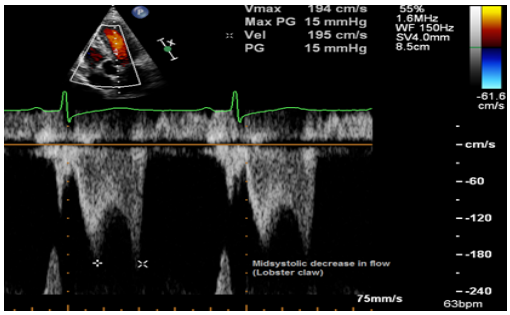


LVOT Obstruction
Late peaking, dagger-shaped profile

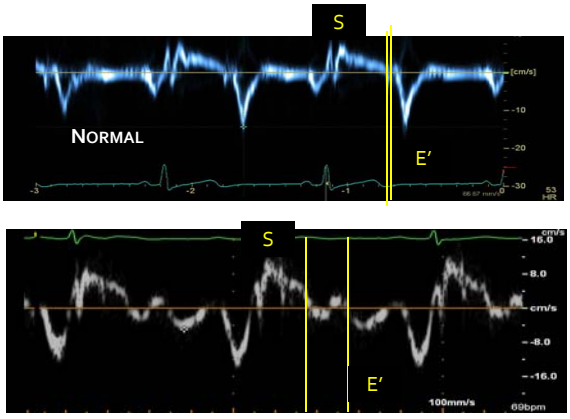


Mitral Regurgitation
Late systolic, very high velocity

HOCM: Spectral Doppler Patterns



Mid-Ventricular Obstruction
Lobster claw profile



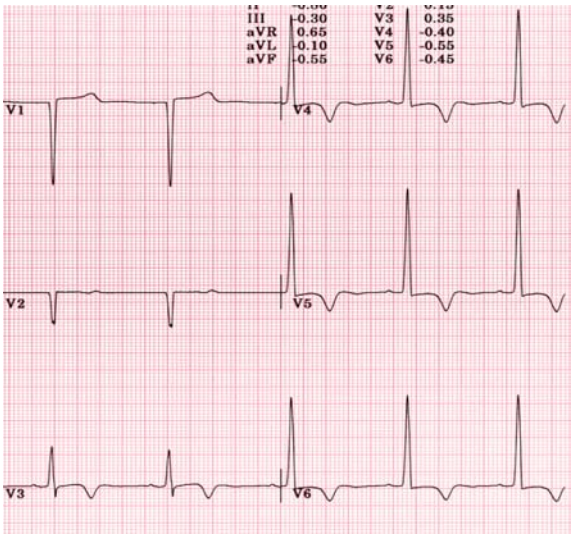
Mitral Tissue Doppler
Premature cessation of S wave

CONCLUSION

Hypertrophic Obstructive Cardiomyopathy

57-year-old woman

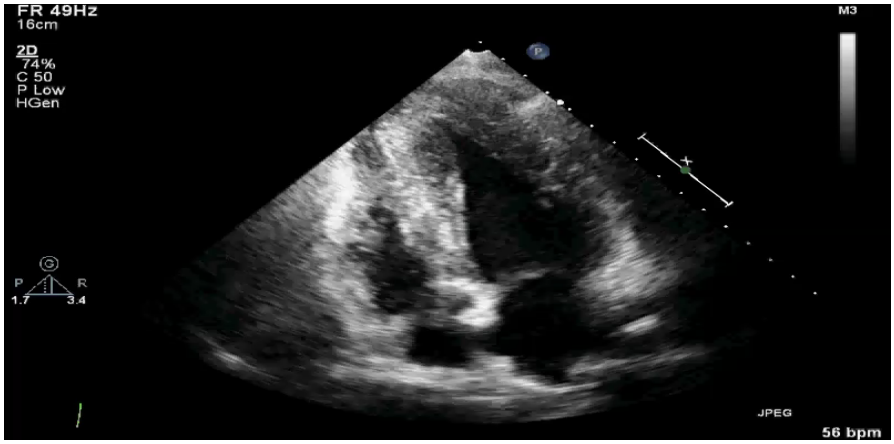
- Asymptomatic
- Abnormal pre-employment EKG



EKG
Left ventricular hypertrophy
with **symmetric** T wave inversions

57-year-old woman

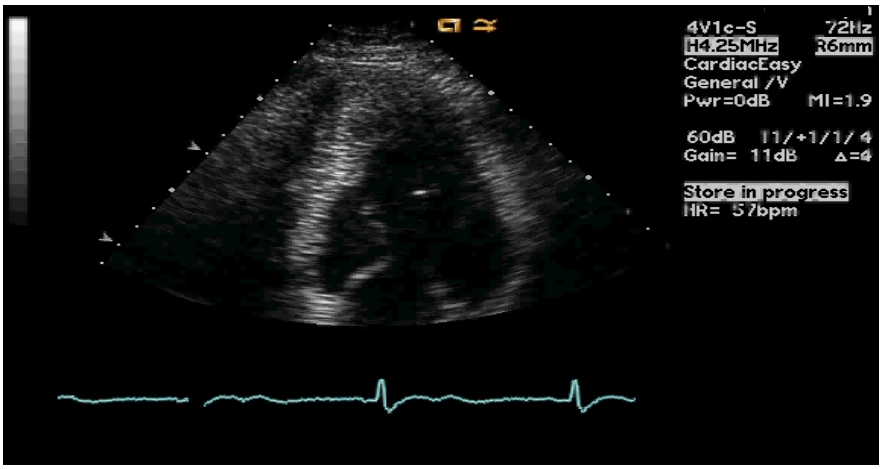
- Hypertension
- Her nephew has hypertrophic cardiomyopathy



TTE | Apical 4-Chamber View
Apical variant of hypertrophic cardiomyopathy

33-year-old man

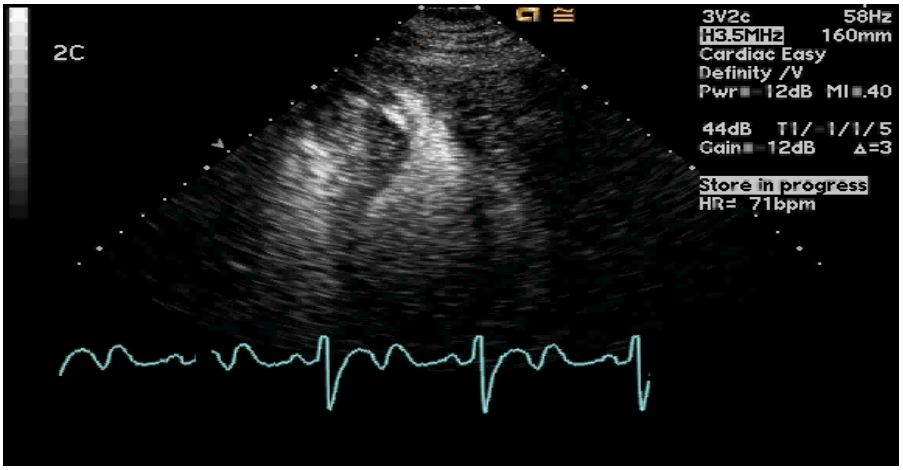
- Heart failure symptoms



TTE | Apical 4-Chamber View

33-year-old man

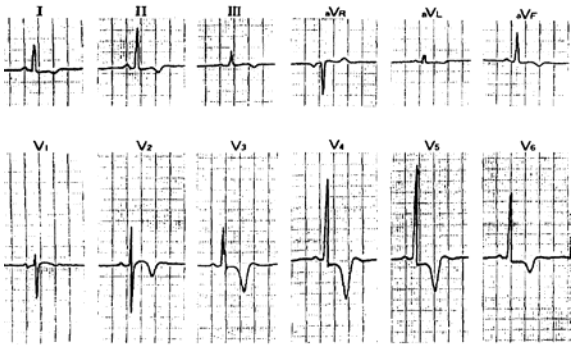
- Heart failure symptoms



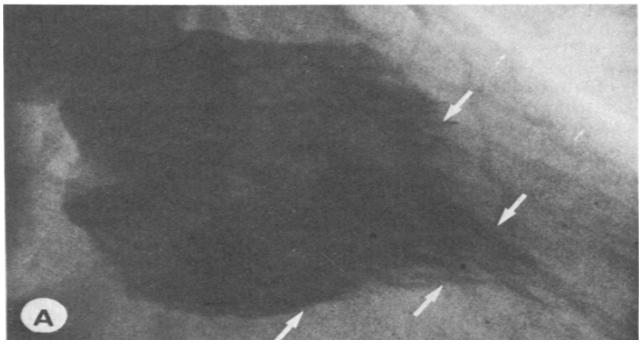
TTE | Perflutren microbubble echo contrast
Apical variant of hypertrophic cardiomyopathy

ORIGINAL DESCRIPTION OF APICAL HCM

Japanese population | *Am J Cardiol.* 1979 Sep;44(3):401-12



EKG
Left ventricular hypertrophy with **giant** T wave inversions



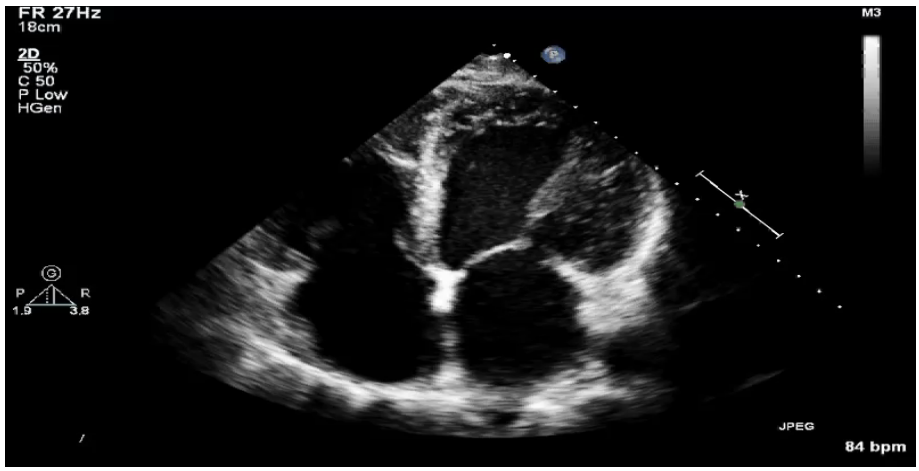
RAO Ventriculogram
Spade shaped heart at end diastole

CONCLUSION

Apical Variant of Hypertrophic Cardiomyopathy

33-year-old man

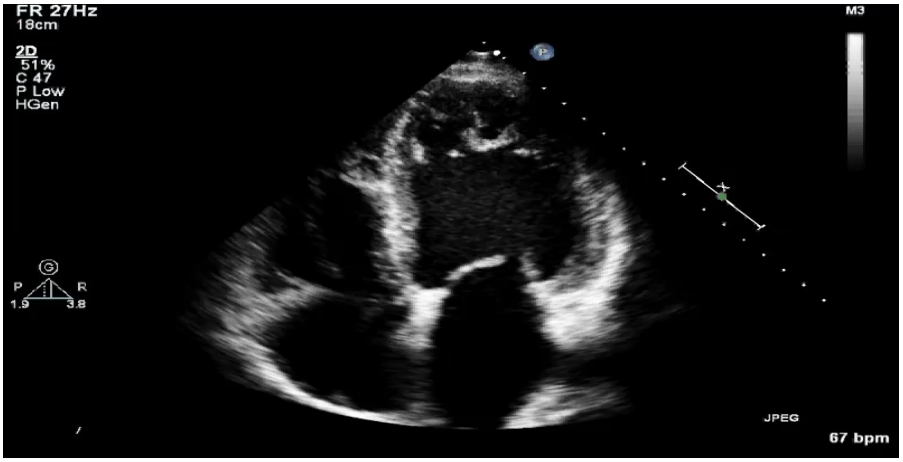
- Recent heart failure symptoms



A4C VIEW | FORESHORTENED
Correct diagnosis **not** fully visualized

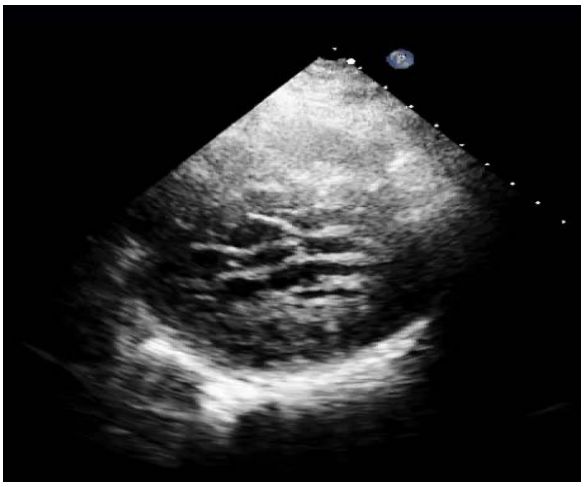
33-year-old man

- Recent heart failure symptoms

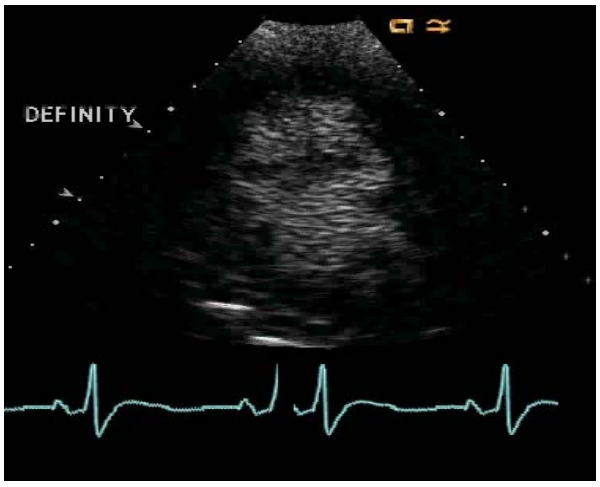


A4C VIEW | NOT FORESHORTENED
Isolated LV Noncompaction cardiomyopathy

NONCOMPACTION LV CARDIOMYOPATHY



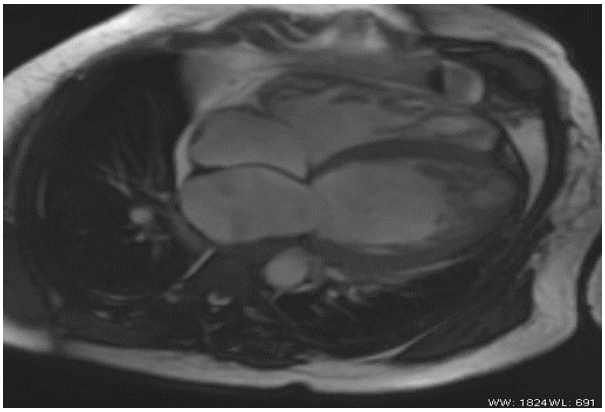
APICAL SAX VIEW | NO CONTRAST
33-y/o man | Noncompacted LV

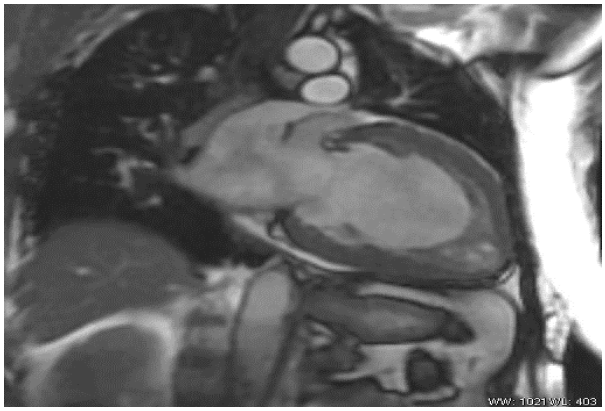


APICAL SAX VIEW | ECHO CONTRAST
46-y/o man | Noncompacted LV

LV NONCOMPACTION

Cardiac MRI



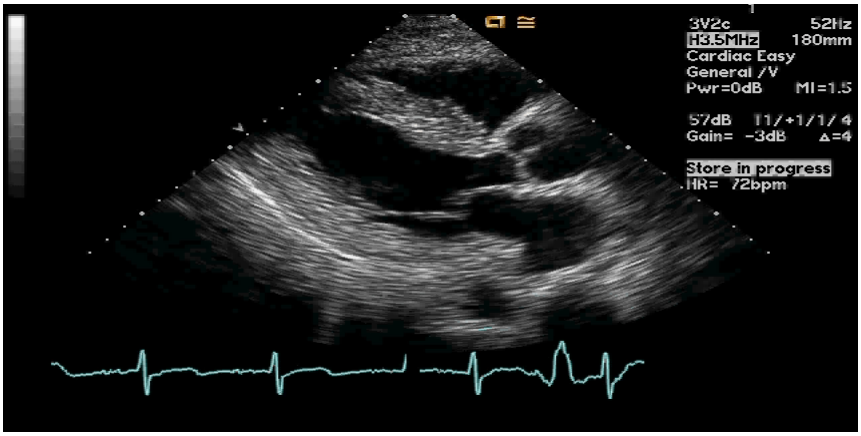


CONCLUSION

Isolated LV Noncompaction Cardiomyopathy

46-year-old man

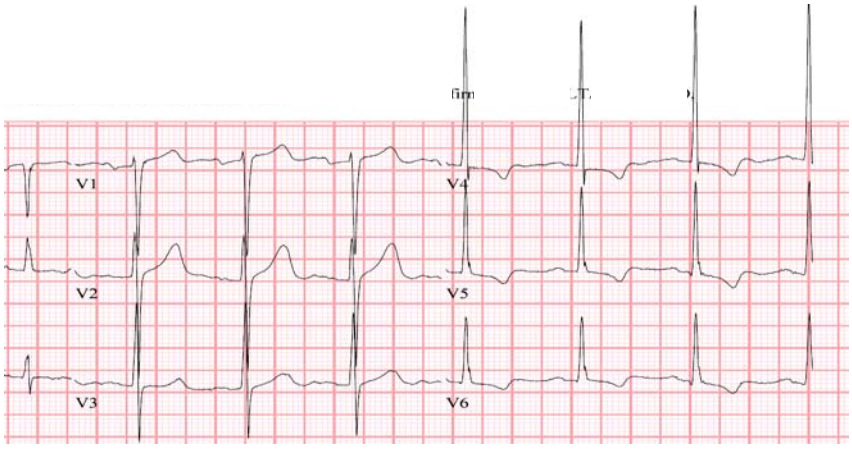
- Hypertensive urgency



TTE | PARASTERNAL LONG-AXIS VIEW
Increased in LV wall thickness

46-year-old man

- Hypertensive urgency



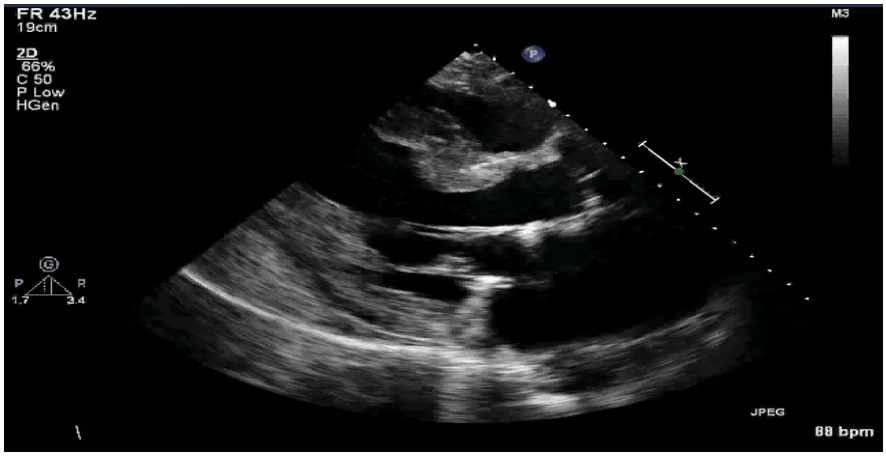
EKG
Left ventricular hypertrophy
with **typical** repolarization changes

CONCLUSION

Hypertensive Heart Disease

53-year-old man

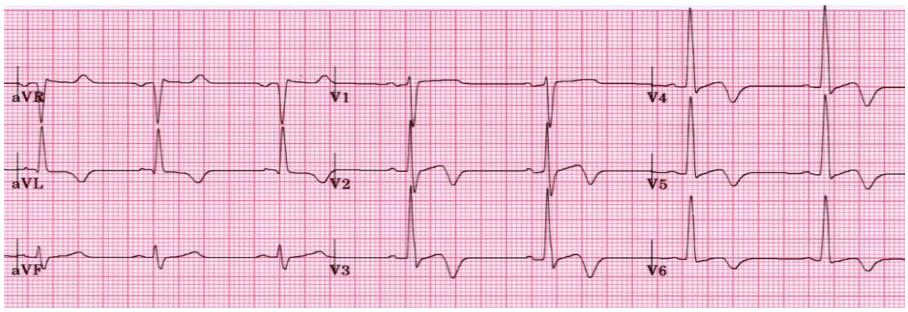
- Hypertension
- Chronic renal insufficiency



TTE | PARASTERNAL LONG-AXIS VIEW
Left ventricular hypertrophy?

53-year-old man

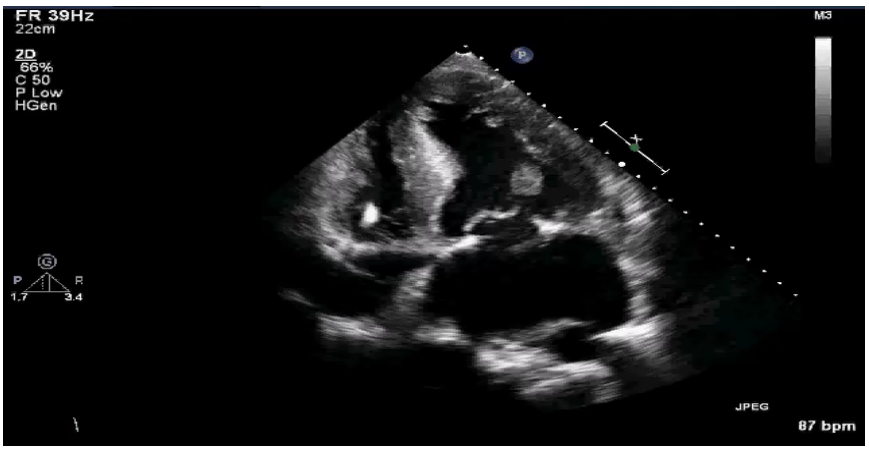
- Hypertension
- Chronic renal insufficiency



EKG
Left ventricular hypertrophy

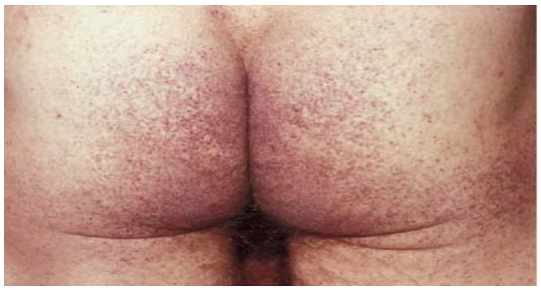
53-year-old man

- Hypertension
- Chronic renal insufficiency

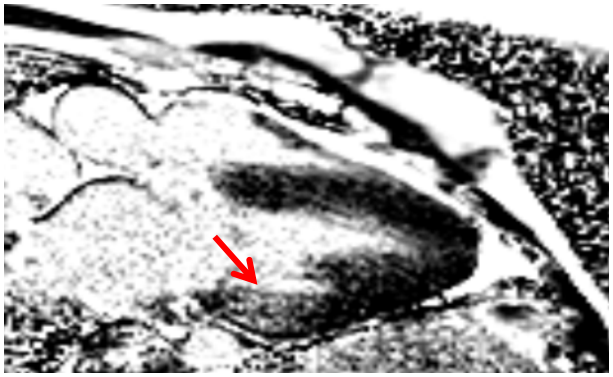


TTE | Apical 4-Chamber View
Pacemaker wire | Mitral annuloplasty ring

Additional Findings



Skin
Angiokeratomas



Cardiac MRI
Fibrosis in the **basal inferolateral** LV

Conclusion

Fabry's Disease

JOHANNES FABRY
German dermatologist
(1860-1930)

Ein Beitrag zur Kenntniss der Purpura haemorrhagica nodularis (Purpura papulosa haemorrhagica Hebrae).

Von

Dr. med. Joh. Fabry in Dortmund.

(Hierzu Tafel VII—X.)

Die im Folgenden mitgetheilte Krankengeschichte, welche wir in letzter Zeit zu beobachten Gelegenheit hatten, bietet, wie wir glauben, ein nicht geringes Interesse dar, weil der Fall nach genauer Durchsicht der Literatur klinisch als ein Unicum bezeichnet werden muss und ebenso pathologisch-anatomisch. Zugleich aber begeben wir uns überhaupt auf ein Gebiet der Dermatonosen, welches nach der Eintheilung der verschiedenen zur Hauptgruppe gehörenden Krankheitsbilder, nach der pathologischen Anatomie und endlich nach der Aetiologie ein allerdings viel bebautes, aber keineswegs ausgebautes Feld darstellt.

Es zeigt sich das beispielsweise schon darin, dass selbst die Lehrbücher über Hautkrankheiten, auch die neueren, kaum einen übereinstimmenden Standpunkt einnehmen.

Wenn wir nun etwas weiter ausholen, so möchten wir hinsichtlich der Purpura-Erkrankungen am liebsten der Auffassung Schwimmer's in Ziemssen's Handbuch folgen, der 1. Purpura simplex haem., 2. Purpura rheumatica haem., 3. Morbus maculosus Werlhofii und 4. Purpura scorbutica unter ein Genus bringen und als Abarten ein und derselben Erkrankung bezeichnen will. Und zwar aus folgenden Gründen

Fabry, J. Ein Beitrag zur Kenntniss der Purpura haemorrhagica nodularis (Purpura papulosa haemorrhagica Hebrae)

[A contribution to the knowledge of Purpura haemorrhagica nodularis (Purpura papulosa haemorrhagica Hebrae)]

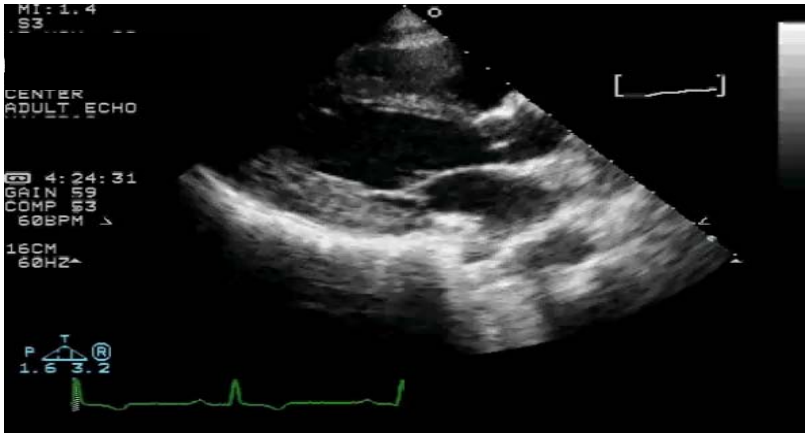
Archiv für Dermatologie und Syphilis
1898;43(1):187-200.

FABRY'S DISEASE

- X-linked recessive disorder
  - Male patient with affected maternal relatives
- Patients die in their 50's
- Alpha-galactosidase deficiency
  - Glycolipid accumulation in lysosomes of blood vessels
- No typical habitus or ethnic preference
- Cardiac manifestations
  - LVH (on EKG & Echo)
  - Fabry's disease may account for 3% of patients with LVH
  - Aortic root dilatation
  - Mitral valve prolapse
  - Conduction abnormalities

22-year-old woman

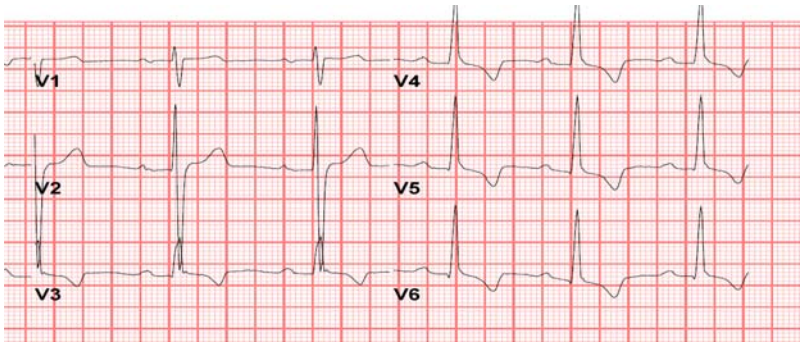
- Asymptomatic
- Referred for 'screening TTE'



TTE | Parasternal Long-Axis View
Left ventricular hypertrophy?

22-year-old woman

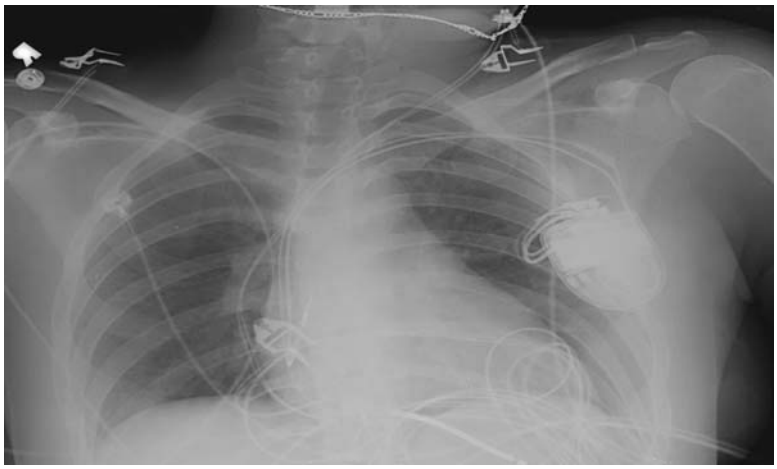
- Asymptomatic
- Abnormal pre-employment EKG



EKG
Left ventricular hypertrophy
with **typical** repolarization changes

22-year-old woman

- Asymptomatic
- Abnormal pre-employment EKG



Chest X-Ray
Pacemaker/Defibrillator

FAMILY HISTORY

BROTHER

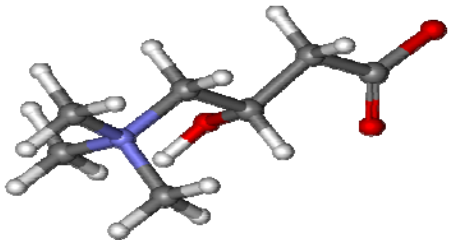
Homozyogous for carnitine transporter gene mutation.

Died as a teenager despite carnitine supplementation

PATIENT

Heterozygous for carnitine transporter gene mutation.

Marked improvement in cardiomyopathy post carnitine supplementation



CARNITINE

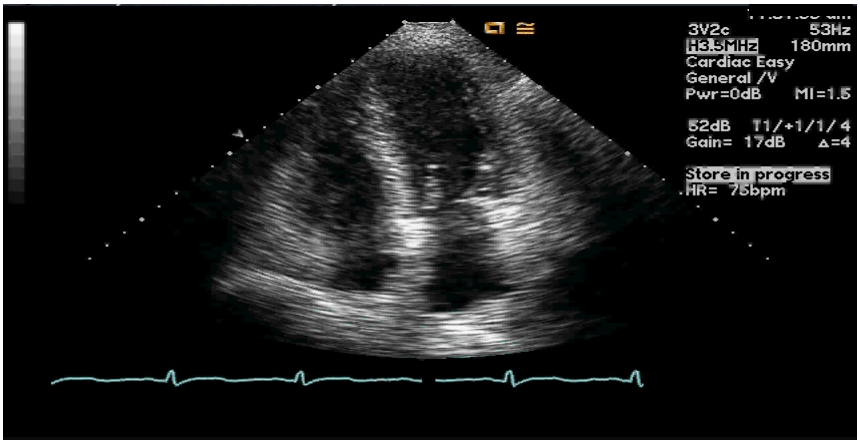
- *Lysine + Methionine derivative.*
- *Essential for fatty acid transport into mitochondria*
- *Gene mutations in renal carnitine transporter gene >> carnitine wasting*

CONCLUSION

Cardiomyopathy Due to Carnitine Uptake Deficiency

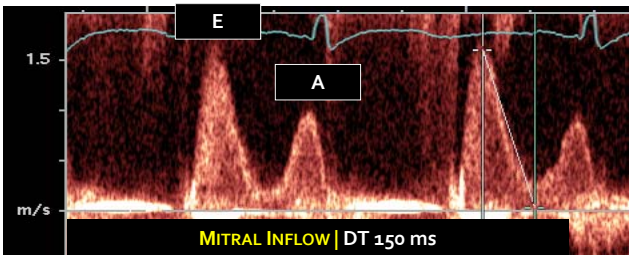
61-year-old woman

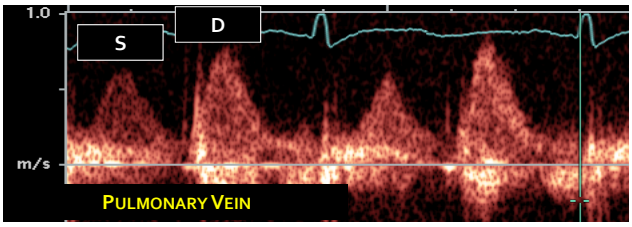
- Hypertension
- Ethanol abuse
- Liver cirrhosis
- Shortness of breath

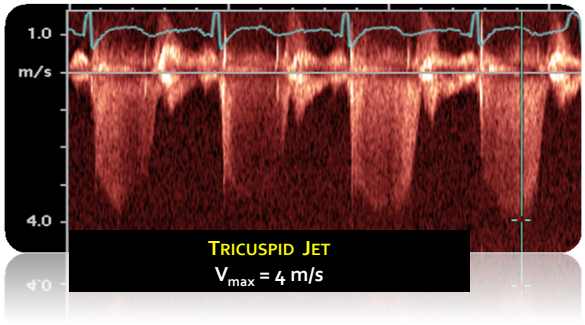


TTE | APICAL 4-CHAMBER VIEW
Cardiomyopathy?

Spectral Doppler







Restrictive mitral filling pattern + Severe pulmonary hypertenison

61-year-old woman

- Hypertension
- Ethanol abuse
- Liver cirrhosis
- Being evaluated for liver transplant

Laboratory Data

Iron Studies

IRON	78
TIBC	96
FERRITIN	1110
TRANSFERRIN	66

Iron saturation
= Iron / TIBC
= 78/96 = 81% (normal <50%)

Ferritin
1110 ng/mL (normal <200)

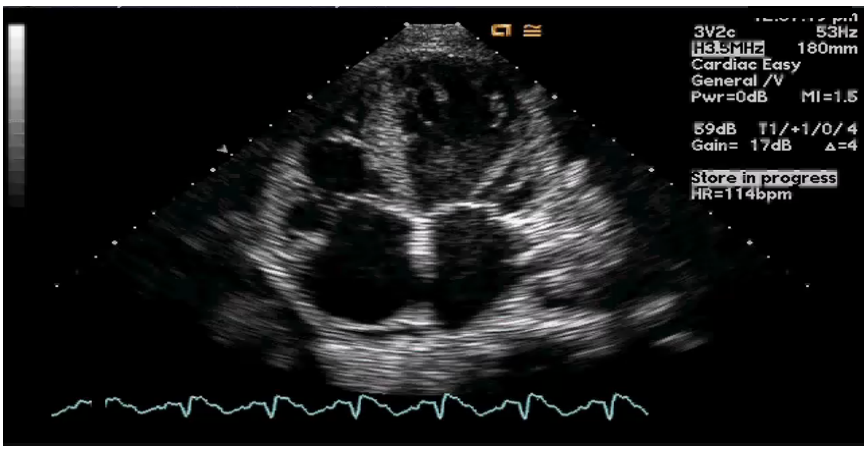
Patient has iron overload

CONCLUSION

Hemochromatosis

59-year-old man

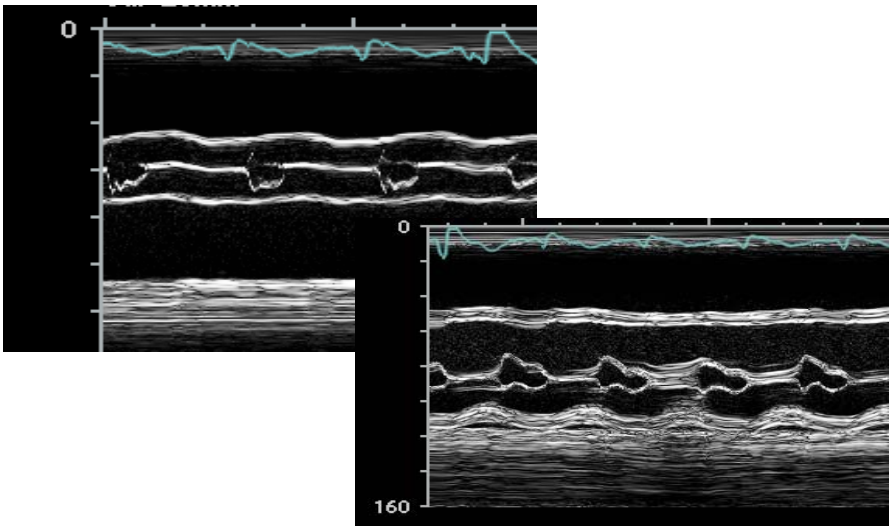
- Hemo-chromatosis



TTE | APICAL 4-CHAMBER VIEW
Dilated Cardiomyopathy

59-year-old man

- Hemo-chromatosis



M MODE

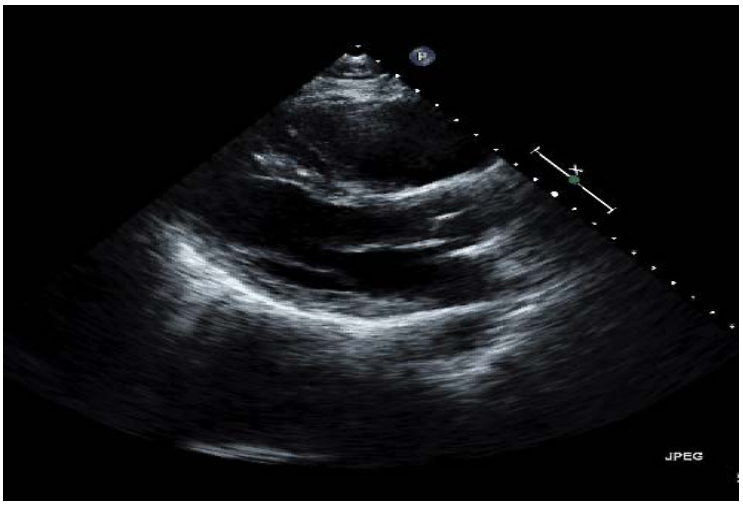
Signs of severe LV systolic dysfunction

CONCLUSION

Hemochromatosis

54-year-old male physician

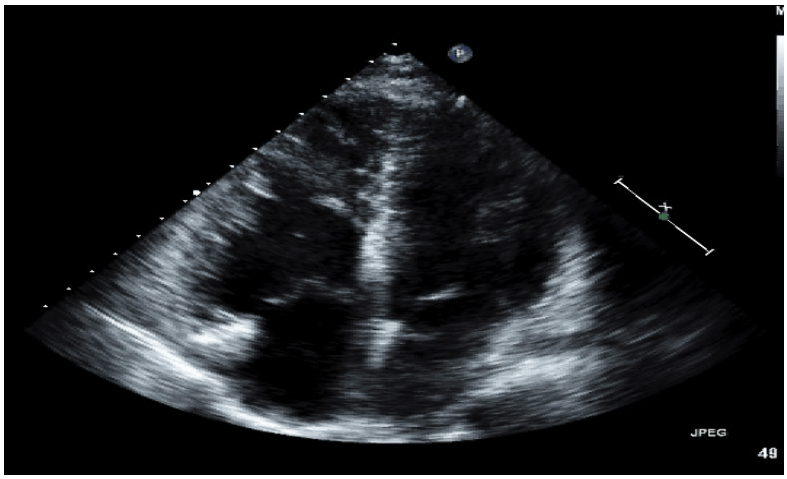
- Presents with recurrent palpitations
- 5 years earlier had an episode of exercise-induced RVOT ventricular tachycardia



TTE | PARASTERNAL LONG-AXIS VIEW
Cardiomyopathy?

54-year-old male physician

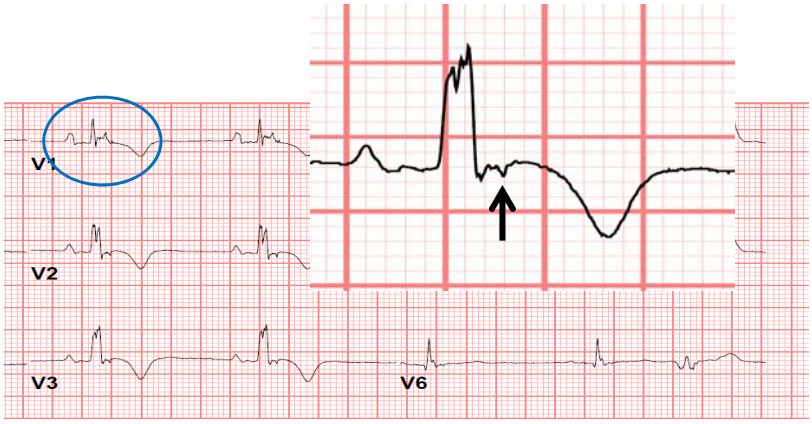
- Presents with recurrent palpitations
- 5 years earlier had an episode of exercise-induced RVOT ventricular tachycardia



TTE | APICAL 4-CHAMBER VIEW
No significant valvular disease, ASD or pulmonary hypertension

54-year-old male physician

- Presents with recurrent palpitations
- 5 years earlier had an episode of exercise-induced RVOT ventricular tachycardia



EKG
Peculiar RBBB

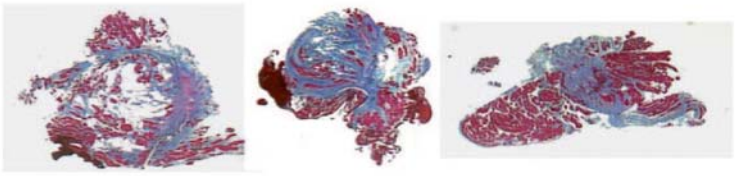
ARRHYTHMOGENIC RV DYSPLASIA

Congenital cardiomyopathy with **autosomal dominant** transmission

Mutations in proteins of **desmosomes** (structures connecting adjacent cells)

Fibrofatty replacement of myocytes

RA & RV dilatation & dysfunction without volume or pressure overload



ORIGINAL DESCRIPTION OF ARRHYTHMOGENIC RV DYSPLASIA

ARRHYTHMOGENIC RIGHT VENTRICULAR DYSPLASIA (ARVD)

This is a previously unrecognized form of cardiomyopathy mainly localized to the right ventricle and is usually associated with little or unappreciable alteration in myocardial contractility (34). Isolated cases suggestive of this syndrome have been reported by others (40–42). We have documented a total of 21 cases of this type; 9 of these who were resistant to drug therapy have been treated surgically (Table 27.1). A possible familial form has also been encountered.

The diagnosis may be based on the following criteria:

ECG. The ECG was completely normal in only a small number of cases. In most of the cases, ECG recordings during sinus rhythm indicated right ventricular abnormality on the basis of a delayed right ventricular activation, negative or biphasic T waves in the right precordial leads, and

Fontaine G, Guiraudon G, Frank R. **Mechanism of ventricular tachycardia with and without associated chronic myocardial ischemia: surgical management based on epicardial mapping**. In: Narula OS, ed. Cardiac arrhythmias. Baltimore and London: Williams and Wilkins,1979:516-23.

Table 1. Criteria for Diagnosis of Right Ventricular Dysplasia (5)

I. Global and/or regional dysfunction and structural alterations*
Major
Severe dilatation and reduction of right ventricular ejection fraction with no (or only mild) left ventricular impairment
Localized right ventricular aneurysms (akinetic or dyskinetic areas with diastolic bulging)
Severe segmental dilatation of the right ventricle
Minor
Mild global right ventricular dilatation and/or ejection fraction reduction with normal left ventricle
Mild segmental dilatation of the right ventricle
Regional right ventricular hypokinesia
II. Tissue characterization of wall
Major
Fibrofatty replacement of myocardium on endomyocardial biopsy
III. Repolarization abnormalities
Minor
Inverted T waves in right precordial leads (V_2 and V_3) in people age >12 yrs, in absence of right bundle branch block
IV. Depolarization/conduction abnormalities
Major
Epsilon waves or localized prolongation (>110 ms) of the QRS complex in right precordial leads (V_1–V_3)
Minor
Late potentials (signal-averaged ECG)
V. Arrhythmias
Minor
Left bundle branch block type ventricular tachycardia (sustained and nonsustained) by ECG, Holter, or exercise testing
Frequent ventricular extrasystoles (>1,000/24 h) (Holter)
VI. Family history
Major
Familial disease confirmed at necropsy or surgery
Minor
Family history of premature sudden death (<35 yrs) due to suspected right ventricular dysplasia
Familial history (clinical diagnosis based on present criteria)

Echocardiography

J Am Coll Cardiol 2005;45:860–5

CONCLUSION

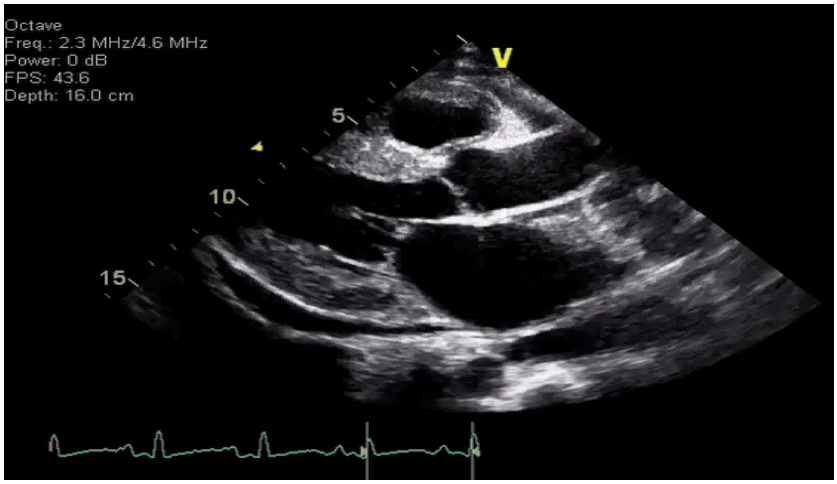
ARVD/ARVC is an **autosomal dominant** inherited cardiomyopathy

♦

Regional or global
RV and RA dilatation & dysfunction
without volume or pressure overload

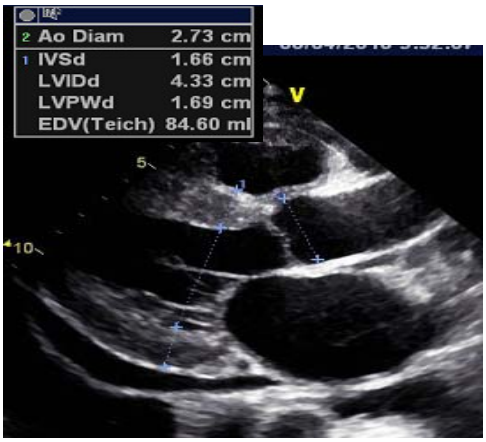
54-year-old man

- Hypertension
- Clinical signs of heart failure

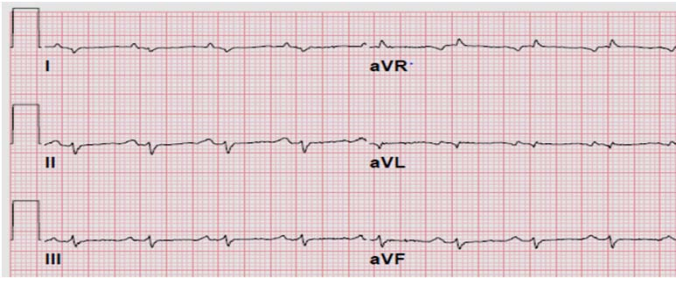


TTE | PARASTERNAL LONG-AXIS VIEW
Left ventricular hypertrophy?

LVH Discrepancy | TTE vs. EKG



Low QRS Voltage

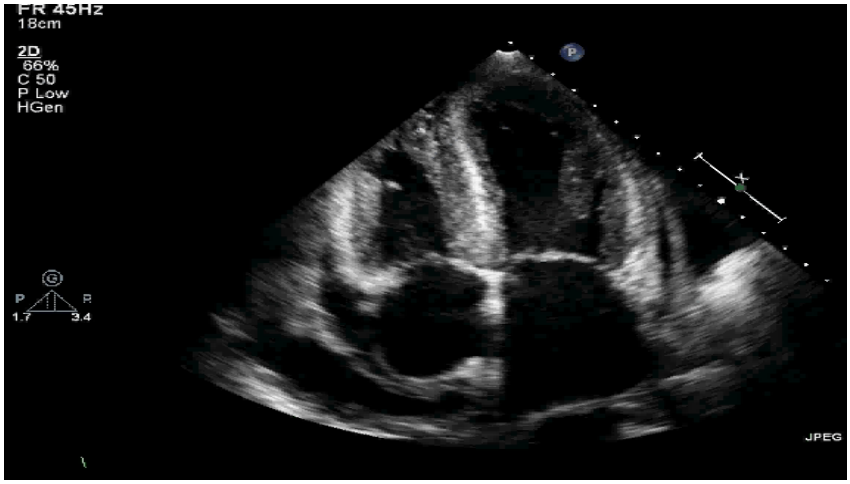


Limb leads < 5 mm; V leads < 10 mm

Discrepancy between apparent LVH on echo and no LVH on EKG is often the first clue in diagnosing cardiac amyloidosis.

54-year-old man

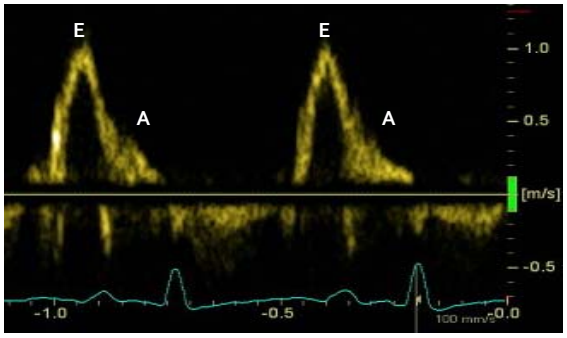
- Hypertension
- Multiple myeloma (AL amyloid)



TTE | Apical 4-Chamber View
Left ventricular hypertrophy?

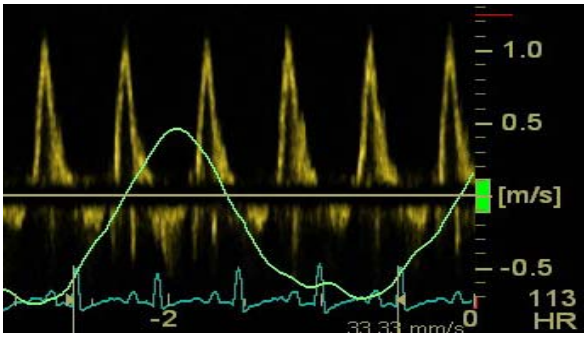
Amyloidosis: LV Diastolic Dysfunction

Mitral Inflow



RESTRICTIVE FILLING PATTERN
E/A > 2
E wave deceleration time < 150 msec

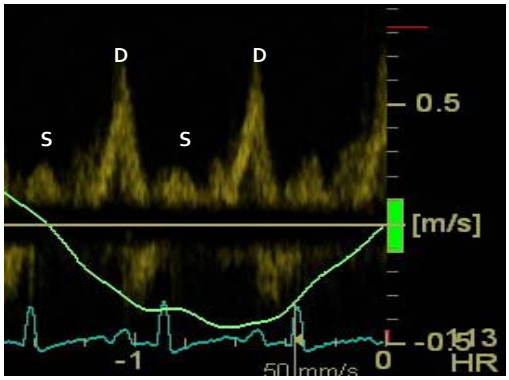
Mitral Inflow with Respirometry



NO RESPIRATORY VARIATIONS IN E WAVE
(in contrast to constriction)

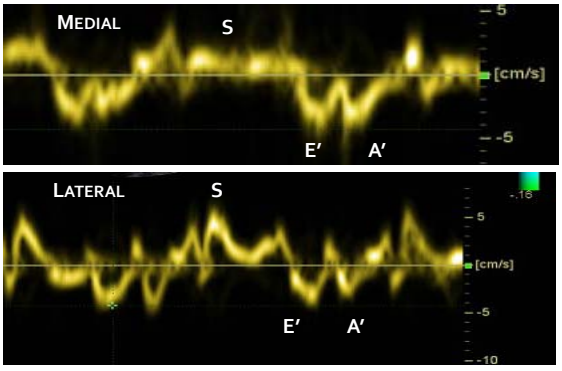
Cardiac Amyloidosis: LV Diastolic Dysfunction

Pulmonary Vein Flow



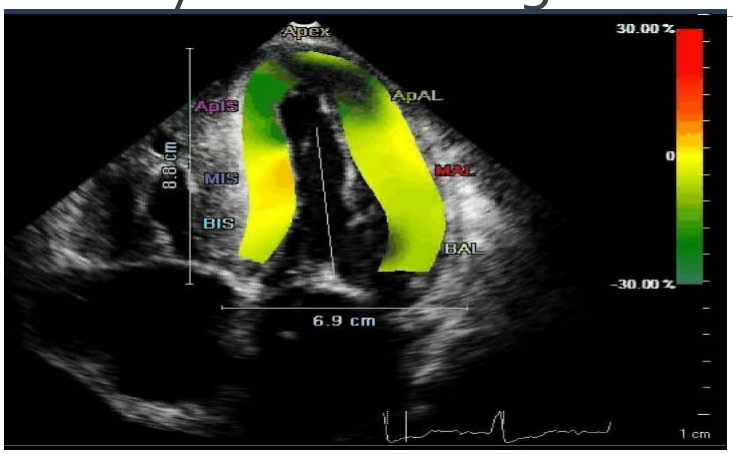
S << D
(indicative of high LA pressure)

Mitral Annular Tissue Doppler



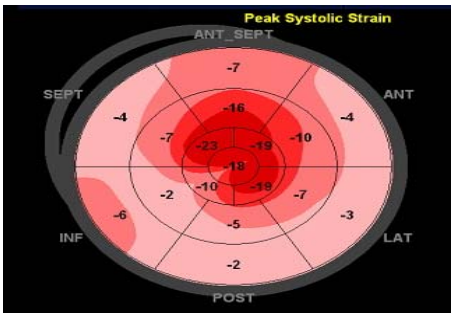
LOW MEDIAL & LATERAL VELOCITIES
(indicative of diminished longitudinal LV function)

Amyloidosis: Longitudinal Strain



APICAL SPARING
Despite globally diminished longitudinal strain, apical strain is relatively preserved.

Cardiac Amyloidosis



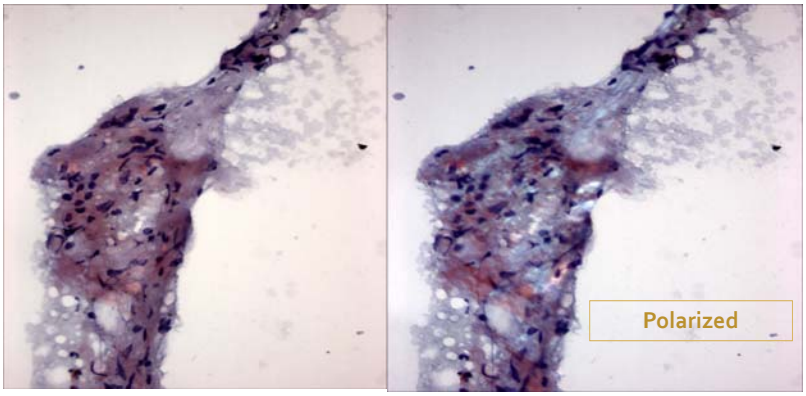
Global longitudinal
peak systolic strain = – 10%

Apical sparing – typical finding in amyloidosis

Cardiac Amyloidosis: Tissue Diagnosis

Typical biopsy sites
- Abdominal wall fat pad
- Endomyocardium

CONGO RED stained fat pad biopsy.



CONCLUSION

Cardiac Amyloidosis

Thank You!

New York University Langone Medical Center