

The background features a dark gray, almost black, central area. This is framed by vibrant green geometric shapes on the left and right sides. These shapes are composed of various triangles and polygons, some overlapping, creating a dynamic, low-poly aesthetic. The green shades range from a bright lime green to a deeper forest green.

IN THE NAME OF GOD

# CARDIOMYOPATHY

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- ▶ Heterogeneous heart muscle diseases
- ▶ Associated with structural remodeling and abnormalities of cardiac function
- ▶ Important causes of morbidity and mortality in the pediatric population

## TYPES:

- ▶ Based on cardiac function
- ▶ Systolic dysfunction:
  - ▶ ***-Dilated cardiomyopathy*** : most common form, left ventricular (LV) dilation and decreased LV systolic function

## ٢- *Left ventricular noncompaction* :

- ▶ Trabeculated LV apex and lateral wall, with a heterogeneous group of associated phenotypes (most often a dilated phenotype with LV dilation and dysfunction).
- ▶ Diastolic dysfunction:

### ١- *Hypertrophic cardiomyopathy*.

- ▶ Increased ventricular wall thickness, normal or increased systolic function, diastolic abnormalities

### ٢-*Restrictive cardiomyopathy*.

- ▶ Near-normal ventricular chamber size and wall thickness , preserved systolic function, impaired diastolic function(elevated filling pressures and atrial enlargement)

- ▶ ***Arrhythmogenic right ventricular cardiomyopathy :***

Fibrofatty infiltration and replacement of the RV myocardium and occasionally the left ventricle => RV and LV systolic and diastolic dysfunction and arrhythmias

- ▶ *Cardiomyopathies may be primary or associated with other organ involvement*

- ▶ Gene Mutations and Cardiac Manifestations of Neuromuscular Disorders

## ***Dilated cardiomyopathy:***

- ▶ The most common form in children
- ▶ Significant morbidity and mortality
- ▶ Indication for cardiac transplantation

## ***Etiology:***

### *1-Ischemic :*

- ▶ Rare in children(ALCAPA, premature coronary atherosclerosis (homozygous familial hypercholesterolemia, progeria(rare genetic syndrome), and inflammatory diseases(Kawasaki disease)

## ┆- *Genetic:*

- ▶ 50% (usually autosomal dominant; some are autosomal recessive or X-linked), including some with metabolic cause
- ▶ *Duchenne and Becker* muscular dystrophies are X-linked cardiomyopathies that account for 5–10% of DCM cases
- ▶ *Mitochondrial* myopathies, disorders of *fatty acid oxidation*

## ┆- *Anthracycline cardiotoxicity*

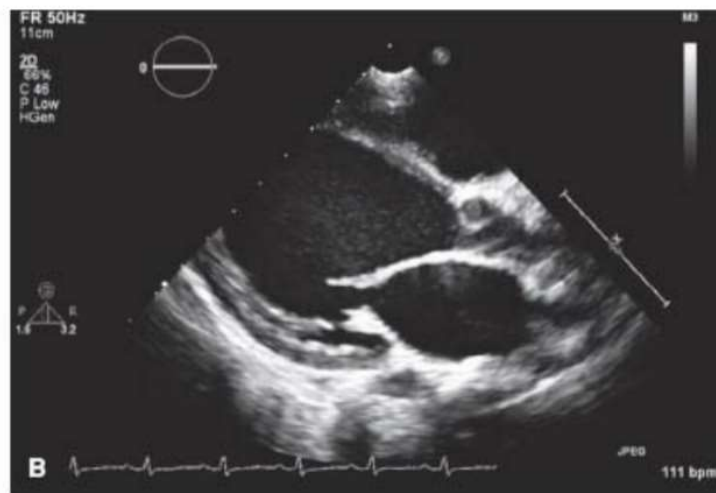
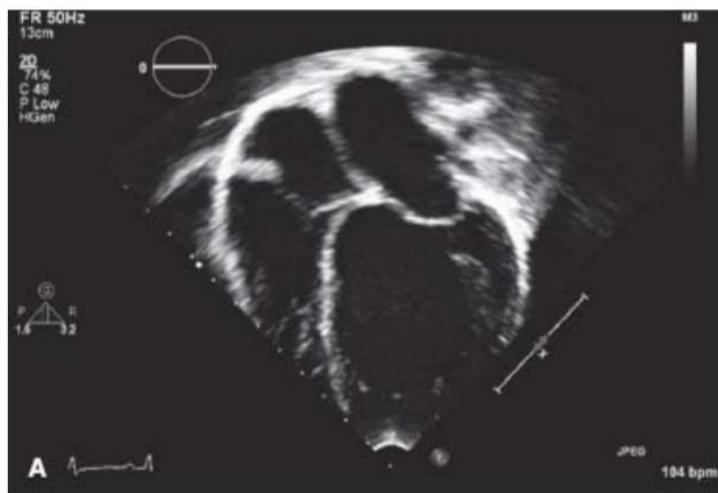
## ┆- *Idiopathic : the most common*

## ***Clinical Manifestations :***

- ▶ Heart failure=> palpitations, syncope, and sudden death.
- ▶ Irritability or lethargy
- ▶ Failure to thrive, nausea, vomiting, or abdominal pain
- ▶ Respiratory symptoms (tachypnea, wheezing, cough, or dyspnea on exertion)
- ▶ Pallor, altered mentation, hypotension, and shock
- ▶ Tachycardic with narrow pulse pressure

## ***Diagnosis :***

- ▶ ***ECG*** => atrial or ventricular hypertrophy, nonspecific T-wave abnormalities, and occasionally, atrial or ventricular arrhythmias  
*ALCAPA* => abnormal Q wave in leads I and aVL , V<sub>4</sub>-V<sub>6</sub> , abnormal R wave progression in left precordial leads
- ▶ ***CXR*** => cardiomegaly and pulmonary vascular prominence or pleural effusions
- ▶ ***Echocardiography*** => LV enlargement, decreased ventricular contractility, RV enlargement and depressed function ,evidence of pulmonary hypertension, mitral regurgitation, or other structural cardiac or coronary abnormalities.



- ▶ **Cardiac MRI** => suboptimal imaging echocardiographic windows or concern of acute myocarditis
- ▶ **Lab data** => complete blood count, renal and liver function tests, creatine phosphokinase (CPK), cardiac troponin I, lactate, brain natriuretic peptide (BNP), plasma amino acids, urine organic acids, and an acylcarnitine profile.
- ▶ Screening first-degree family members by echocardiography and electrocardiogram (ECG) in idiopathic and familial cases of DCM

## ***Prognosis and Management :***

- ▶ ***Risk factors*** => older age, heart failure, lower LV fractional shortening z score, and underlying etiologies
- ▶ ١-Careful assessment to uncover possible treatable etiologies
- ▶ ٢-Screening of family members
- ▶ ٣-Rigorous pharmacologic therapy

### ***A-Medication to reverse remodeling :***

- ١-Angiotensin-converting enzyme (ACE) inhibitors
- ٢-Angiotensin receptor blockers (ARBs)
- ٣-B-adrenergic blockade with carvedilol or metoprolol

### ***B-Diuretic :***

- ▶ Furosemide => reduce symptoms of pulmonary or systemic venous congestion

### ***C-Digoxin***

***D-ICD :*** risk of sudden death

### ***E-Pacemakers***

- ▶ Critical cases => inotrope, MCS, VAD, MV, ECMO, transplant

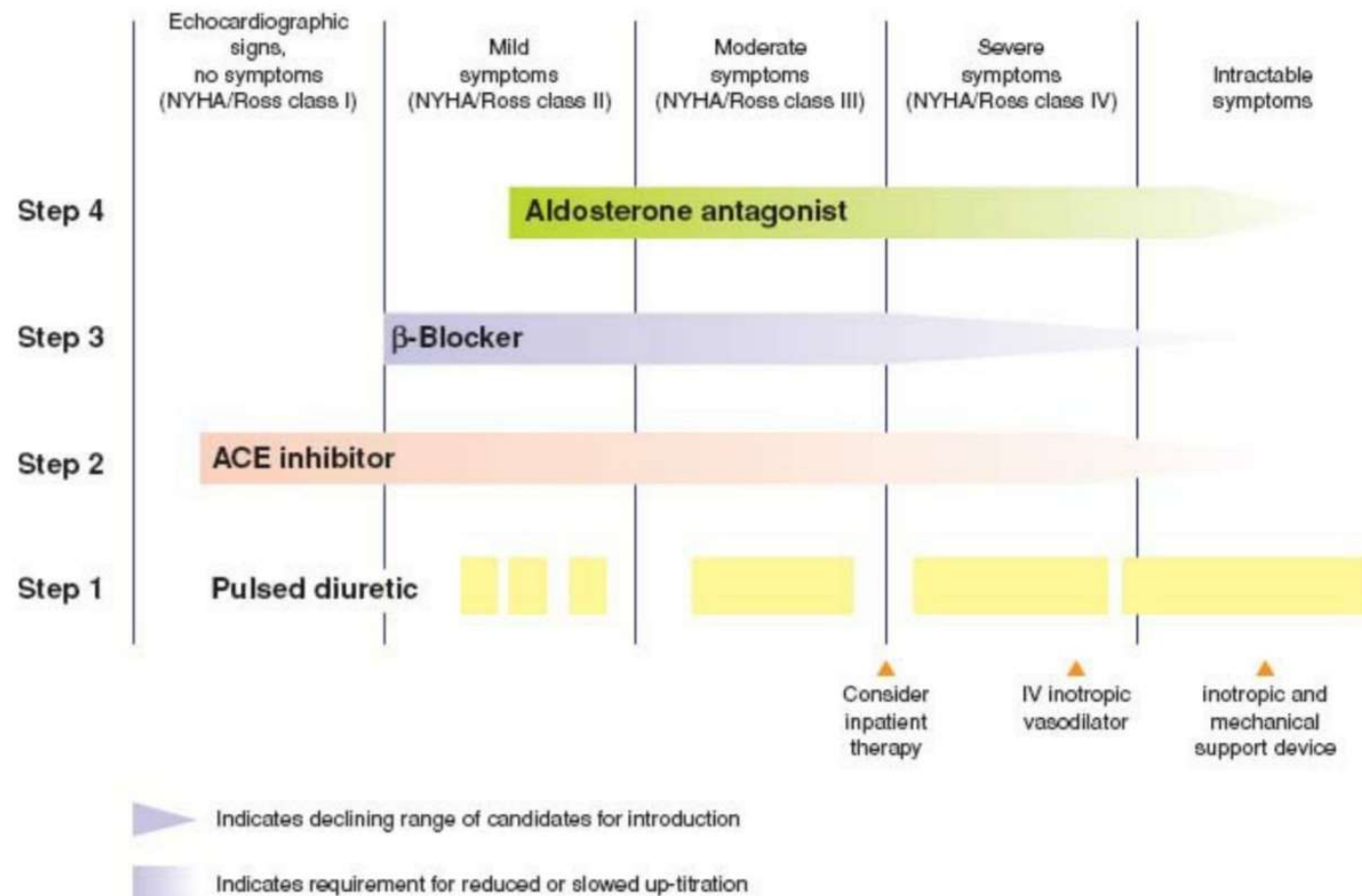
**TABLE 53.4 Recommended Screening Interval for First-Degree Relatives of a Patient with Dilated Cardiomyopathy**

If genetic testing is negative and/or if clinical family screening is negative:	Every 3–5 years beginning in childhood
If genetic testing reveals a disease-causing mutation:	Yearly in childhood; every 1–3 years in adults

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	No Congestion	Congestion
Adequate perfusion	<p><b>“Warm and Dry”</b></p> <p>A</p> <p>Optimal profile: focus on prevention of disease progression and decompensation</p>	<p><b>“Wet and Warm”</b></p> <p>B</p> <p>Diuresis with continuation of standard therapy</p>
Critical hypoperfusion	<p><b>“Cold and Dry”</b></p> <p>L</p> <p>Limited further options for therapy</p>	<p><b>“Wet and Cold”</b></p> <p>C</p> <p>Diuresis and redesign of regimen with other standard therapies</p>

## Stepwise introduction of medical therapy in heart failure



## **Hypertrophic Cardiomyopathy :**

- ▶ Heterogeneous, relatively common, and life-threatening

### ***Etiology :***

- ▶ Inborn errors of metabolism
- ▶ Neuromuscular disorders
- ▶ Syndromic conditions
- ▶ Genetic abnormalities

## ***Mutations:***

- ▶  $\beta$ -myosin heavy-chain (MYH $\gamma$ ) and myosin-binding protein C (MYBPC $\gamma$ ) : the most common
- ▶ PRKAG $\gamma$  and the lysosome-associated membrane protein  $\gamma$   $\alpha$ -galactosidase (Danon disease , glycogen storage disease II B).
- ▶ Noonan syndrome
- ▶ Glycogen storage disorders such as Pompe disease(The characteristic ECG in Pompe disease demonstrates prominent P waves, a short P-R interval, and massive QRS voltages. )

## Pathogenesis :

- ▶ Increased LV wall thickness in the absence of structural heart disease or hypertension
- ▶ Left ventricle is predominantly affected, probable right ventricle involvement particularly in infancy
- ▶ Systolic anterior motion of MV and mitral insufficiency.
- ▶ Left ventricular outflow tract (LVOT) obstruction : 25%, dynamic, may be secondary to the abnormal position of the mitral valve as well as the obstructing subaortic hypertrophic cardiac muscle

- ▶ Preserved systolic function or even hyperdynamic
- ▶ Late systolic dysfunction => a predictor for death or need for transplant

### **Clinical Manifestations :**

- ▶ Asymptomatic
- ▶ Heart murmur
- ▶ Palpitations, chest pain, easy fatigability, dyspnea, dizziness, and syncope
- ▶ Sudden death => uncommon manifestation
- ▶ Systolic ejection murmur in the aortic region , an apical blowing murmur of mitral insufficiency.

## Diagnosis :

### ▶ ***ECG :***

LV hypertrophy with ST segment and T-wave abnormalities (particularly T-wave inversion in the left precordial leads).

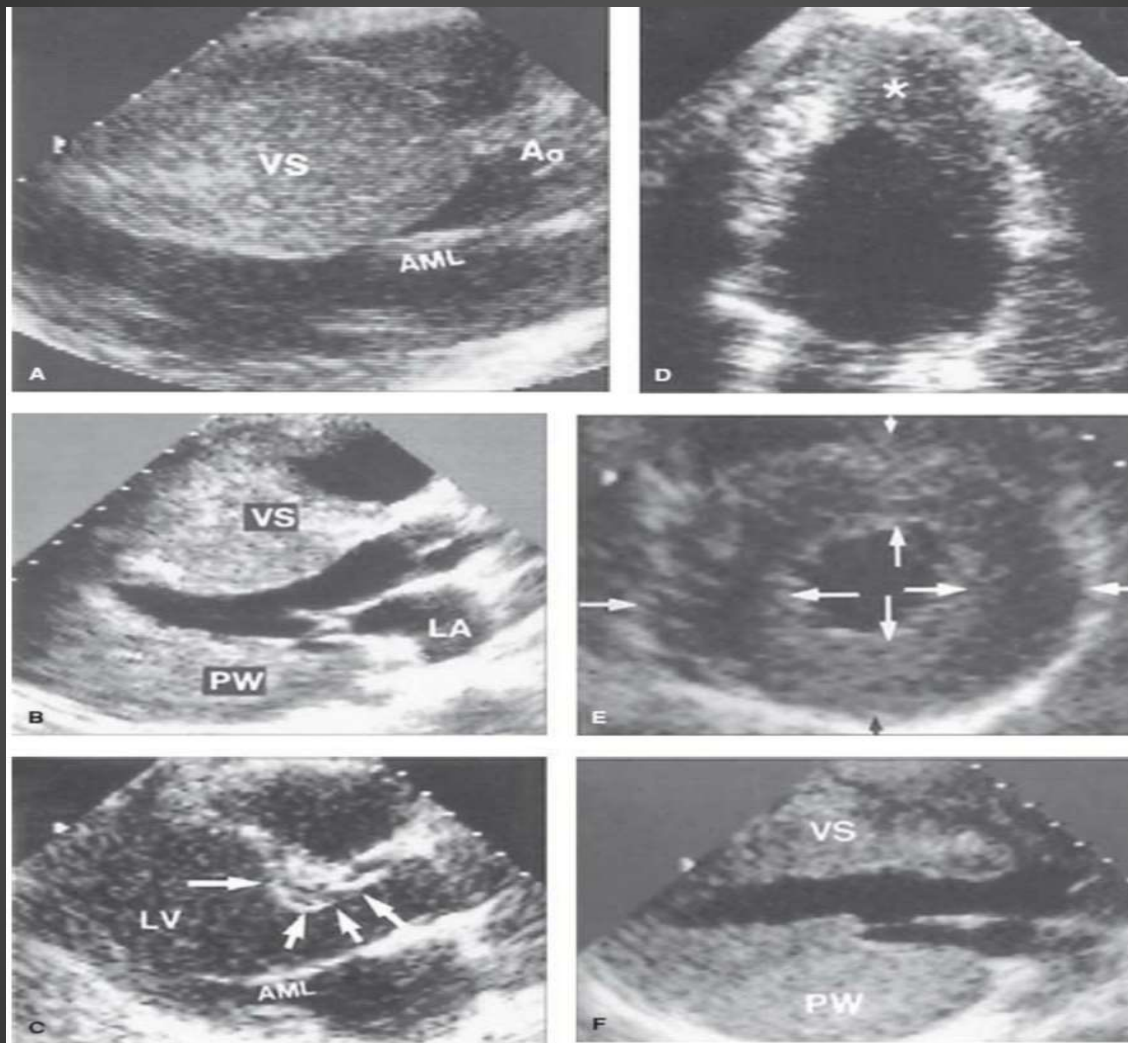
Intraventricular conduction delays and signs of ventricular preexcitation (Wolff-Parkinson-White syndrome ) => the possibility of Danon disease or Pompe disease

▶ ***CXR :*** normal or mildly increased heart size with a prominence of the left ventricle.

▶ ***Echocardiography***

▶ ***Cardiac catheterization*** : rarely used, for a myocardial bridge

▶ ***Metabolic and genetic testing***



## **Prognosis and Management :**

- ▶ Less than one year old and a mixed HCM/DCM =>poorer prognosis.

### **Greater risk of sudden death :**

- ▶ Personal or family history of cardiac arrest
- ▶ Ventricular tachycardia
- ▶ Exercise hypotension
- ▶ Syncope
- ▶ Excessive ( $> 3$  cm) ventricular wall thickness
- ▶ Restriction from competitive sports and strenuous physical activity is highly recommended

## Medication :

1- $\beta$ -Adrenergic blocking agents (propranolol, atenolol, metoprolol)

2-Calcium channel blockers non-dihydropyridine(verapamil)

- ▶ Decrease LVOTO, modify LVH, improve ventricular filling, anti arrhythmic effect

3-Antiarrhythmic therapy : atrial or ventricular arrhythmias

### ***Others:***

- ▶ Dual-chamber pacing
- ▶ Alcohol septal ablation
- ▶ Surgical septal myomectomy, and mitral valve replacement
- ▶ All in patients with significant symptoms despite medical therapy

## **Implantable cardioverter-defibrillator (ICD):**

- ١- Documented, previously aborted sudden cardiac arrest
- ٢- Strong family histories of sudden death
- ٣- Ventricular wall end-diastolic dimensions of  $\geq ٣$  cm
- ٤- Unexplained syncope
- ٥- Nonsustained ventricular tachycardia
- ٦- Blunted or hypotensive blood pressure response to exercise

- ▶ Screening of First-degree relatives with ECG and echocardiogram yearly until young adulthood (age 21 yr) and then every 3-5 yr if no prior evidence of HCM is present.

**TABLE 52.1 Proposed Clinical Family Screening Strategies with Echocardiography and CMR (and 12-lead ECG) for Detection of HCM Phenotype with LVH**

Age  $\leq 12$  yrs

Optional unless:

Malignant family history of premature death from HCM, or other adverse complications

Competitive athlete in an intense training program

Onset of symptoms

Other clinical suspicion or early LVH

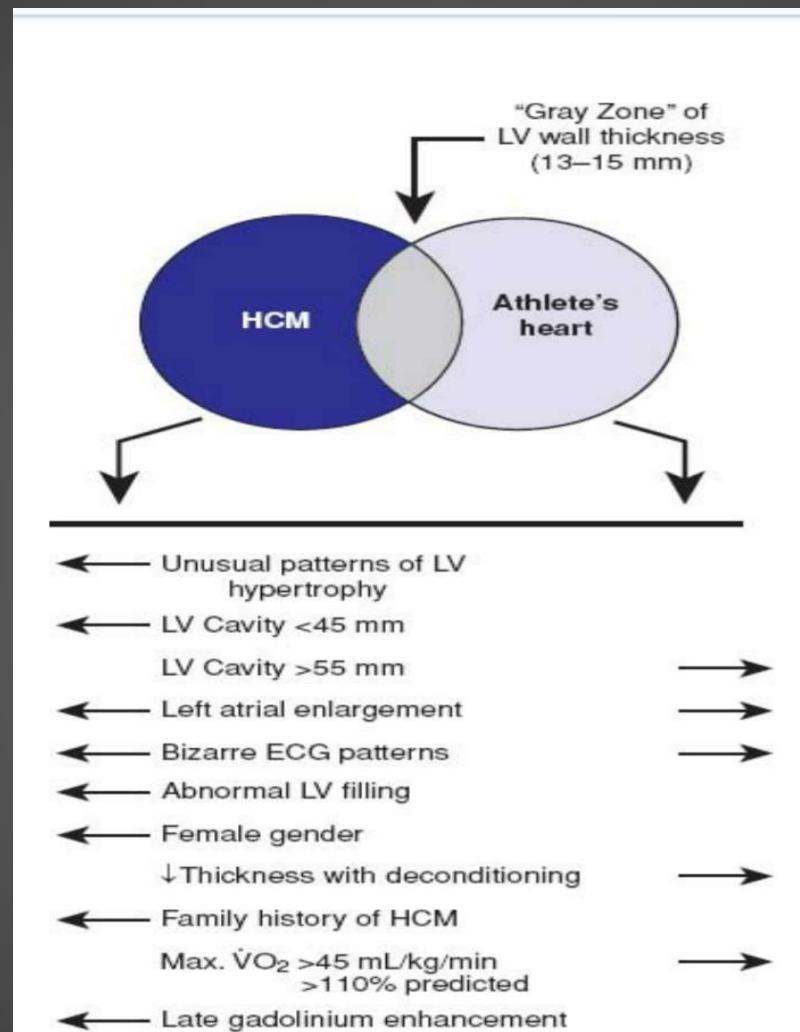
Age 12 to 18–21 yrs<sup>a</sup>

Every 12–18 mo

Age  $\geq 21$  yrs

At onset of symptoms or possibly every 5 yrs. More frequent intervals are appropriate in families with a malignant clinical course or late-onset HCM

<sup>a</sup>Age range takes into consideration individual variability in achieving physical maturity and in some patients may justify screening at an earlier age. Initial evaluation should occur no later than early pubescence.



## **Restrictive Cardiomyopathy :**

- ▶ Less than 1% of cardiomyopathies
- ▶ Incidence increases with age and is more common in females

### ***Etiology:***

- ▶ Infiltrative myocardial causes
- ▶ Storage disorders
- ▶ Non infiltrative causes => mutations in genes encoding sarcomeric or cytoskeletal proteins.

### **Pathogenesis :**

- ▶ Normal ventricular chamber dimensions and myocardial wall thickness, and preserved systolic function
- ▶ Dramatic atrial dilation can result from the abnormal ventricular myocardial compliance and high ventricular diastolic pressure.

## Clinical Manifestations :

- ▶ Diastolic heart failure => edema, hepatomegaly, or ascites.
- ▶ Elevation of left-sided filling pressures => cough, dyspnea, or pulmonary edema.
- ▶ Chest pain, shortness of breath, syncope/near-syncope, or even sudden death with exercise
- ▶ Heart murmurs are typically absent
- ▶ Gallop rhythm may be prominent.
- ▶ In the presence of pulmonary hypertension, an overactive RV impulse and pronounced pulmonary component of the second heart sound (S<sub>2</sub>)

## Diagnosis :

### *ECG :*

- ▶ Prominent P waves with normal QRS voltages and nonspecific ST and T-wave changes. RV hypertrophy in pulmonary hypertension

### *CXR :*

- ▶ Normal or a prominent atrial shadow and pulmonary vascular redistribution

### *Echocardiography :*

- ▶ Normal-sized ventricles with preserved systolic function and dramatic enlargement of the atria
- ▶ It is critical to differentiate RCM from constrictive pericarditis



## **Prognosis and Management :**

- ▶ Poor prognosis poor with progressive clinical deterioration
- ▶ Predisposed to the development of atrial tachyarrhythmias, complete heart block, and thromboemboli => Antiarrhythmic agents, and anticoagulation with platelet inhibitors or warfarin (Coumadin) is indicated.
- ▶ Diuretics, Beta blockers, CCBs
- ▶ Cardiac transplantation is the treatment of choice

## **Left Ventricular Noncompaction :**

### **Pathogenesis :**

- ▶ Distinctive trabeculated or spongy-appearing left ventricle commonly associated with LV dysfunction and/or dilation and hypertrophy, diastolic dysfunction, and arrhythmias
- ▶ Isolated or associated with structural congenital cardiac defects

### **Clinical Manifestations :**

- ▶ Heart failure, arrhythmias, syncope, sudden death, or as an asymptomatic finding during screening of family members.

## Diagnosis :

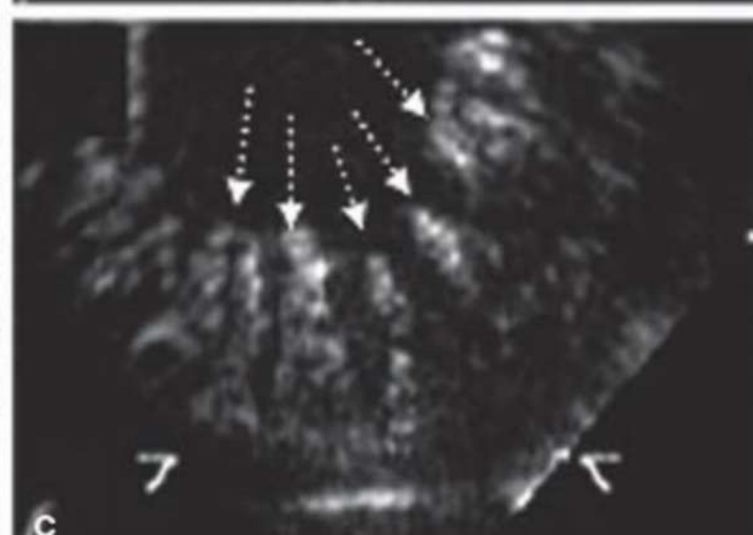
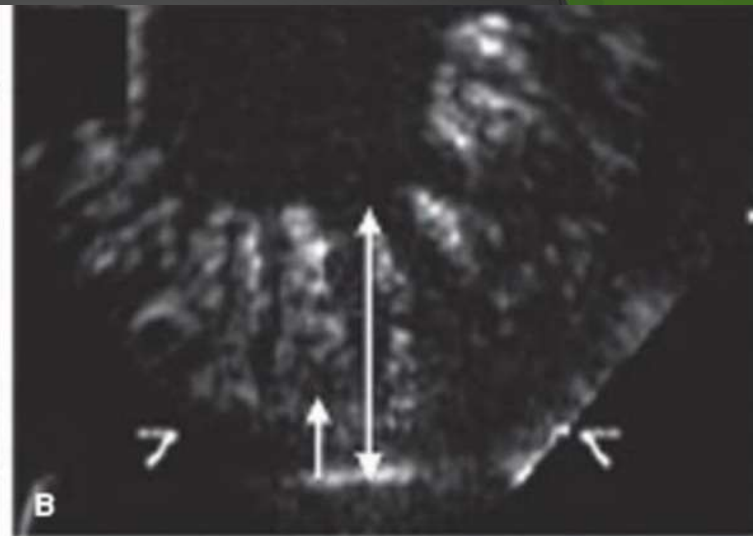
### *ECG :*

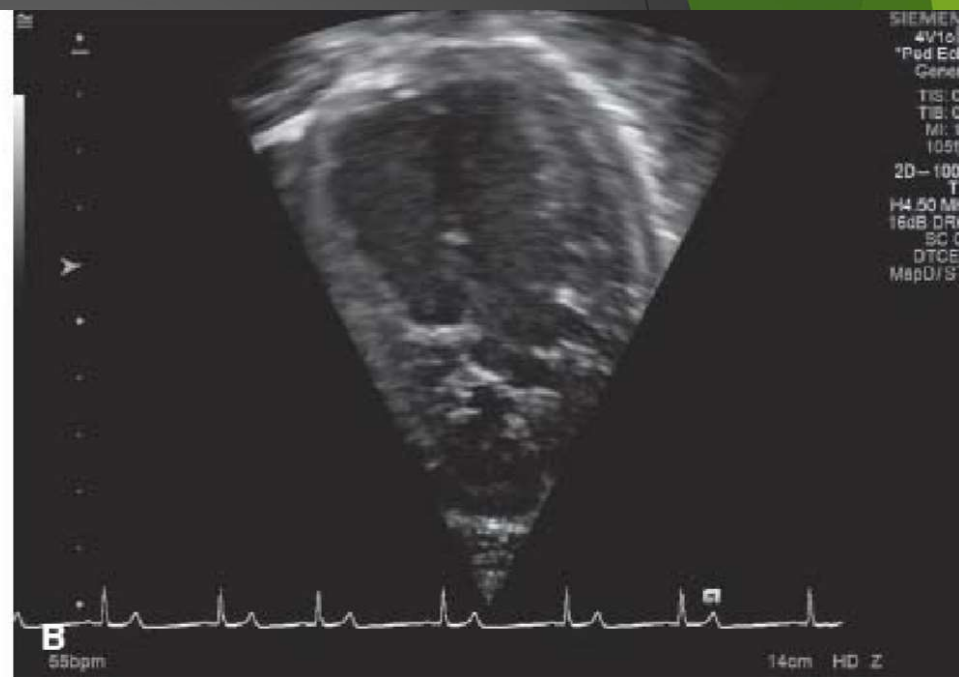
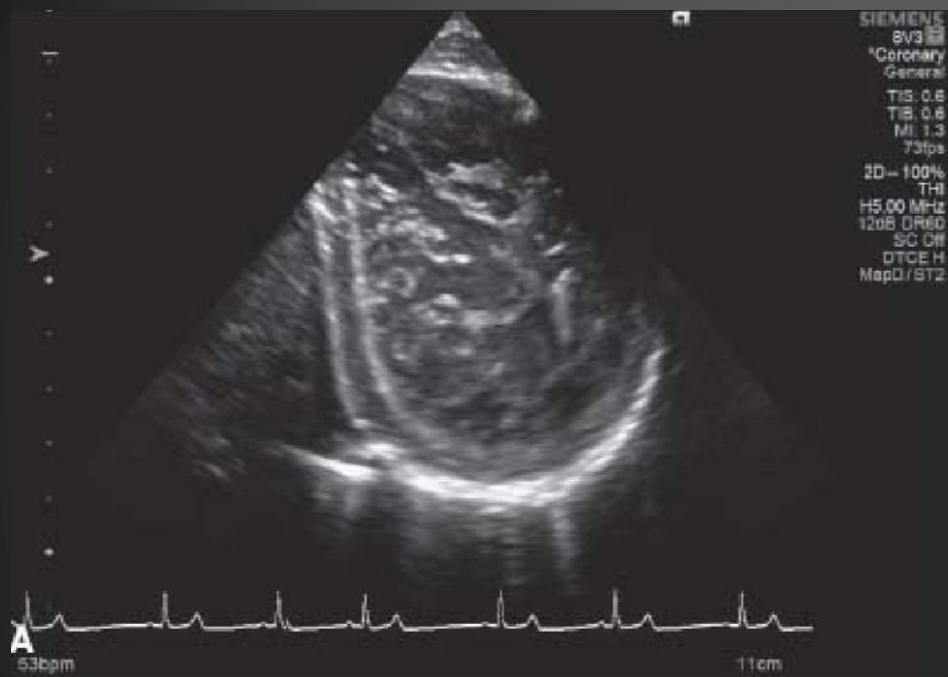
- ▶ Nonspecific ,chamber hypertrophy, ST and T wave changes, or arrhythmia, preexcitation and giant QRS voltages (30%)

### *Echocardiography, MRI :*

- ▶ Characteristic pattern of deeply trabeculated LV myocardium, most characteristically within the apex.

**Metabolic screening => especially in young children**





- ▶ Elevated serum lactate and urine 3-methylglutaconic acid => Barth syndrome , an X-linked disorder of phospholipid metabolism caused by a mutation in the tafazzin (TAZ ) gene
- ▶ Patients with mitochondrial disorders frequently demonstrate signs of LVNC.

### **Treatment :**

- ▶ Anticoagulation
- ▶ Antiarrhythmic therapy if needed
- ▶ Treatment of heart failure if present.
- ▶ Refractory to medical therapy, cardiac transplantation is recommended

## **Arrhythmogenic right ventricular cardiomyopathy (ARVC) :**

- ▶ Autosomal dominant.
- ▶ Recessive forms associated with severe ARVC and skin manifestations
- ▶ Dilated right ventricle with fibrofatty infiltration of the RV wall; increasingly, LV involvement is being recognized.
- ▶ Global and regional RV and LV dysfunction and ventricular tachyarrhythmias are the major clinical findings.
- ▶ Syncope or aborted sudden death => antiarrhythmic medications and placement of an ICD.

## ► **ECG:**

90% EKG abnormality

(1) Inverted T wave in leads V<sub>1</sub> to V<sub>3</sub> (the most common), non-specific, normal variant in RBBB, women, and children under 12 years old

(2) Localized QRS widening in V<sub>1-3</sub> (>110 msec)

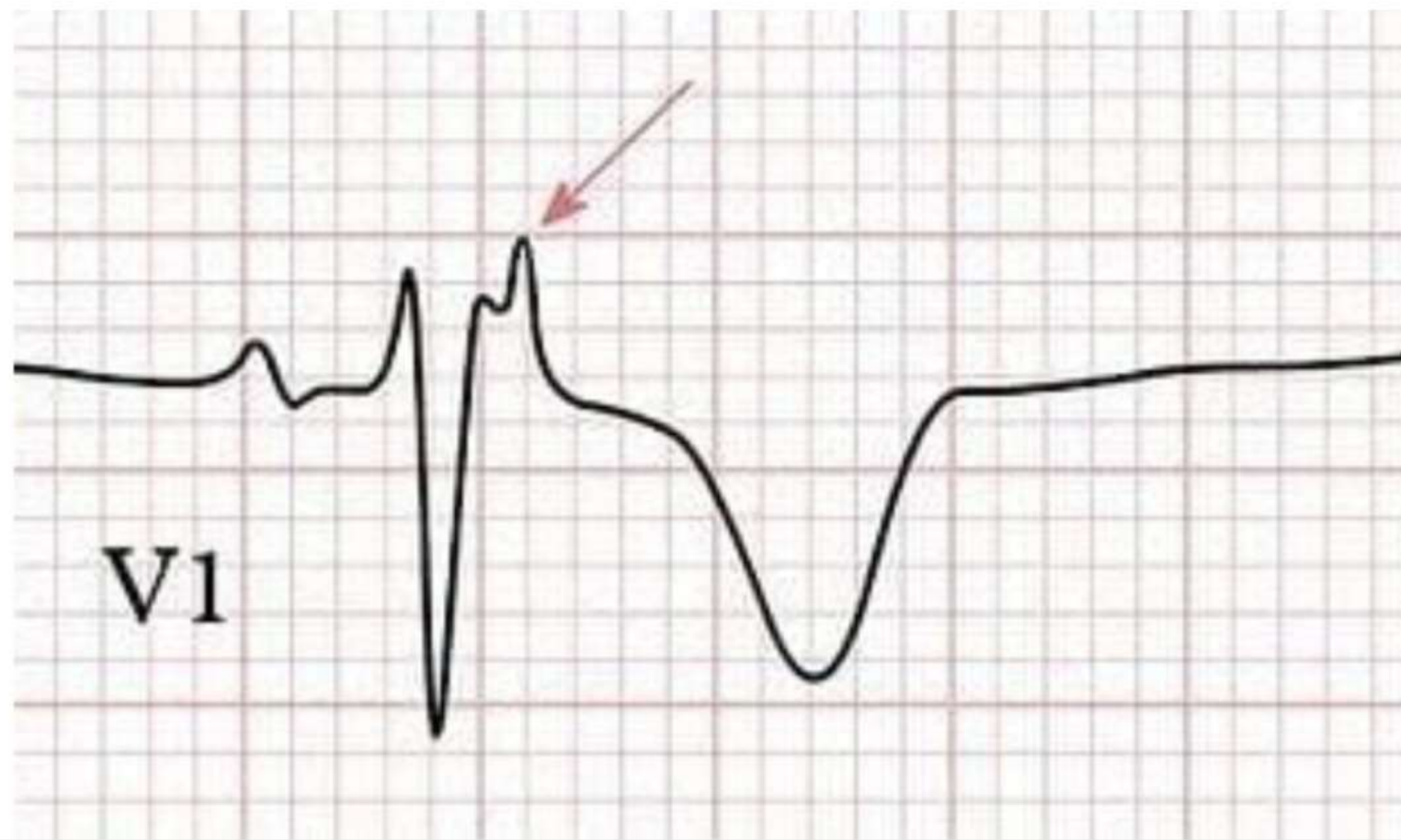
(3) RBBB (due to delayed activation of the right ventricle)

(4) The epsilon wave (50%)- most specific

(5) Prolonged S wave upstroke of 55 msec in V<sub>1-3</sub>.

(6) Paroxysmal episodes of V-tach with LBBB morphology (RVOT origine)

(7) PVC of LBBB morphology >1000 in 24 hours





Prolonged S-wave upstroke in V2 with localized QRS widening

► ***Echo:***

Enlarged, hypokinetic right ventricle with a paper-thin RV free wall.

TV annulus dilatation => Tricuspid regurgitation.

Paradoxical septal motion.

► ***MRI:***

Extreme thinning and akinesia of the RV free wall.

The normal RV free wall may be about 3 mm thick=> making the test less sensitive.

Increased intensity due to fat in T<sub>1</sub>-weighted images

The epicardial fat is commonly seen adjacent to the normal heart => making the differentiation difficult

## ► **Takotsubo cardiomyopathy :**

Reversible stress-induced syndrome

Associated with transient systolic and diastolic dysfunction and regional ventricular wall motion abnormalities characterized by ventricular apical ballooning.

Transient episodes of chest pain or heart failure

## ► **Treatment :**

Heart failure ( $\beta$ -blockers, ACE inhibitors, diuretics)

Addressing the precipitating event (thyrotoxicosis, pheochromocytoma, drug ingestion).



▶ THANK YOU