

Left ventricular hypertrophy on electrocardiography:

-Clinical implications for adult congenital
heart disease -

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The biggest children's hospital in Japan,
promoting transition for adults with
congenital heart disease (ACHD)



Tokyo Metropolitan
Tama Medical Center

Tokyo Metropolitan
Children's Medical Center

Significance of ECG for ACHD

- Non-invasive and cost effective
- Provides clues for first diagnosis in adulthood
- Evaluates cardiac load

↓
Left ventricular hypertrophy (LVH)

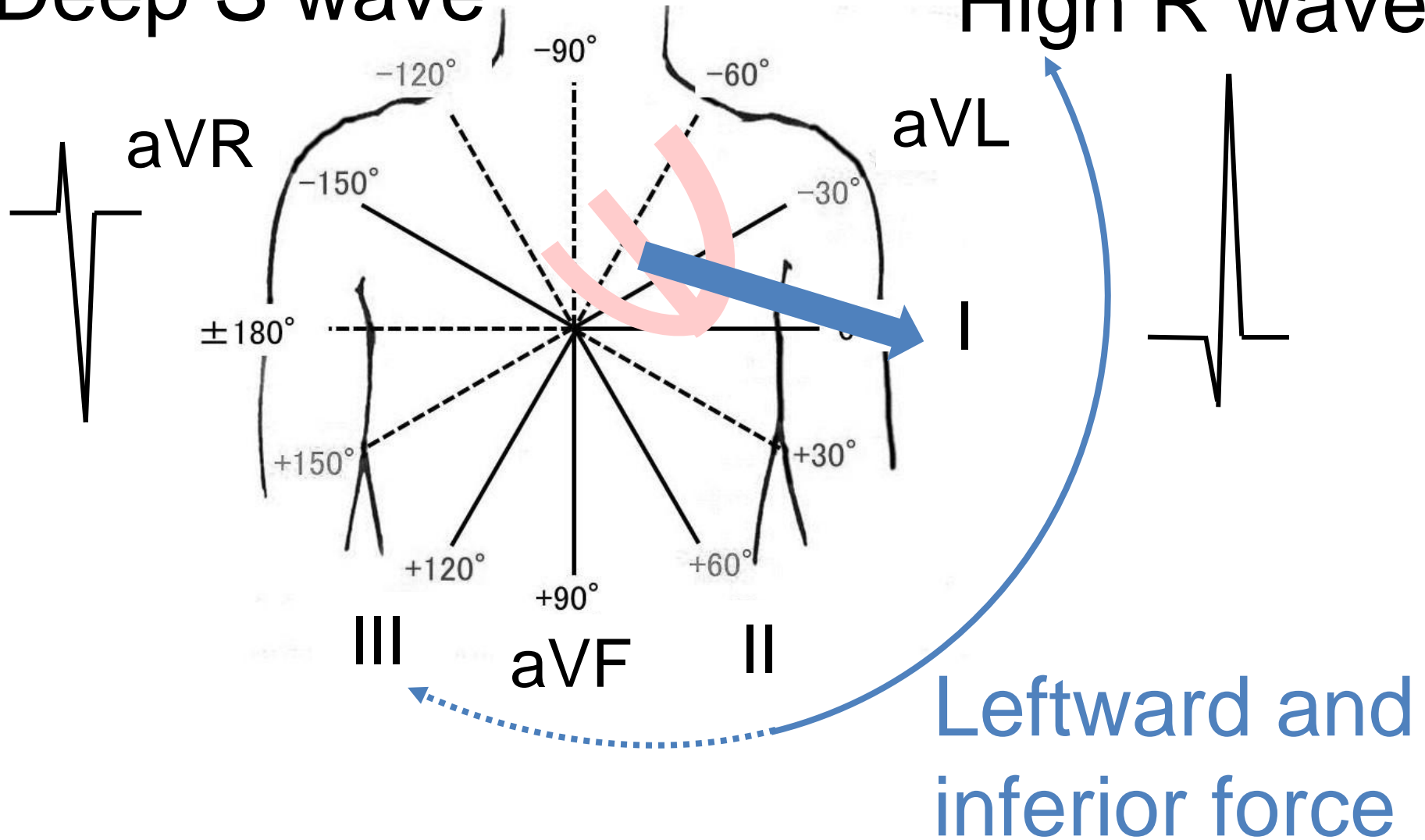
- Helps manage arrhythmia



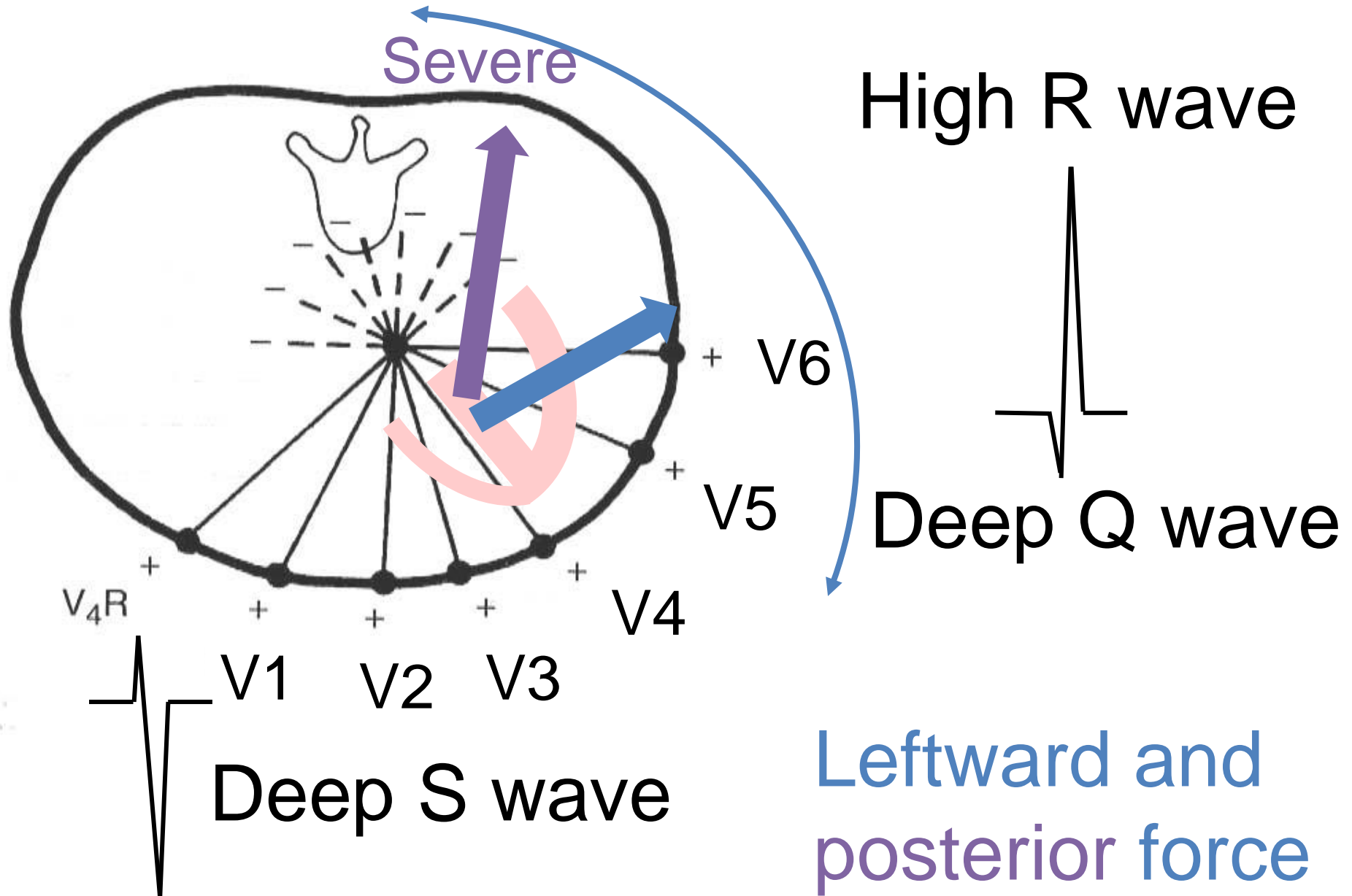
Limb leads in LVH

Deep S wave

High R wave



Chest leads in LVH



Sokolow-Lyon voltage criteria

$$S V 1 + R V 5 \text{ (or } V 6) > 3.5 \text{ mV}$$

$$R a V L > 1.1 \text{ mV}$$

Cornell voltage criteria

$$R a V L + S V 3 > 2.8 \text{ mV (men)}$$

$$2.0 \text{ mV (women)}$$

Cornell product

Romit-Estes score

Several other criteria

**ECG criteria
for LVH**

Factors influencing voltage

Age → applies to > 35 years old

Gender

Race →

Body habitus

Cornell voltage criteria
for Koreans

2.0 mV (men)

1.6 mV (women)

Jin Kyu Park, et al.

Korean Circ J 2012;42:606

+ Congenital heart diseases

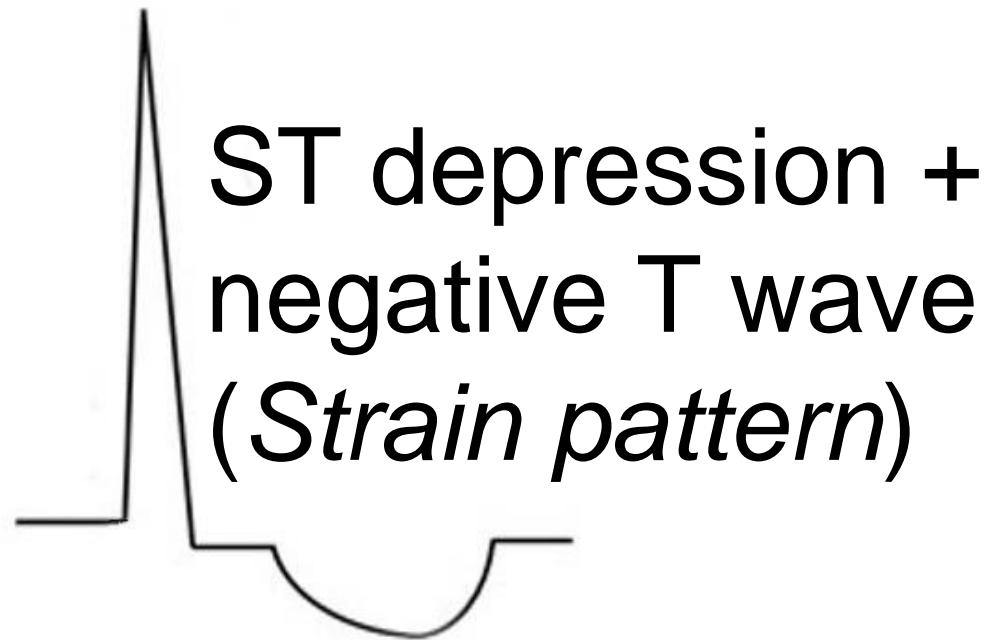
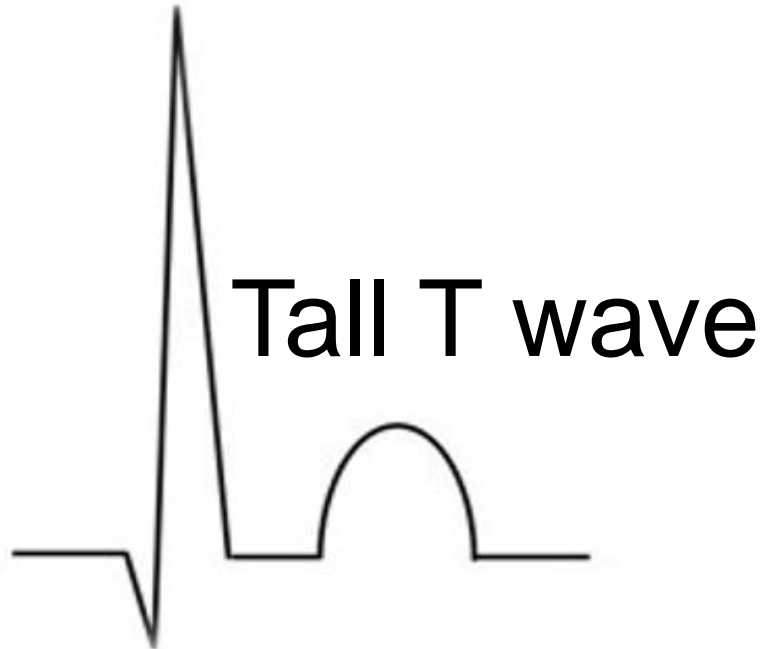
LVH patterns in left-sided leads

Volume overload

Pressure overload

High R wave

High R wave



Deep Q wave

Shallow Q wave

LVH mechanisms in ACHD

Volume overload

Left-to-right shunt

Right-to-left shunt at atrial level

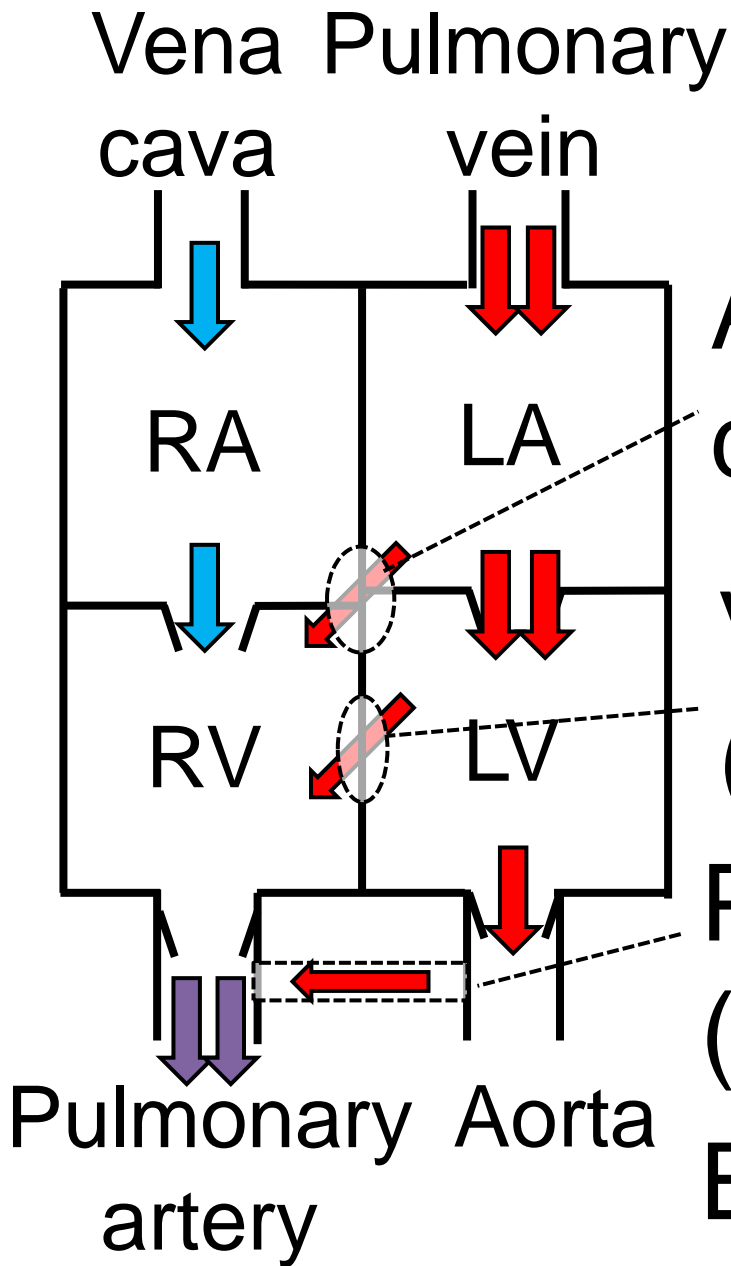
Valve regurgitation

Pressure overload

Valve or aortic stenosis

Hypertension

Left-to-right shunt



Atrioventricular septal defect (AVSD)

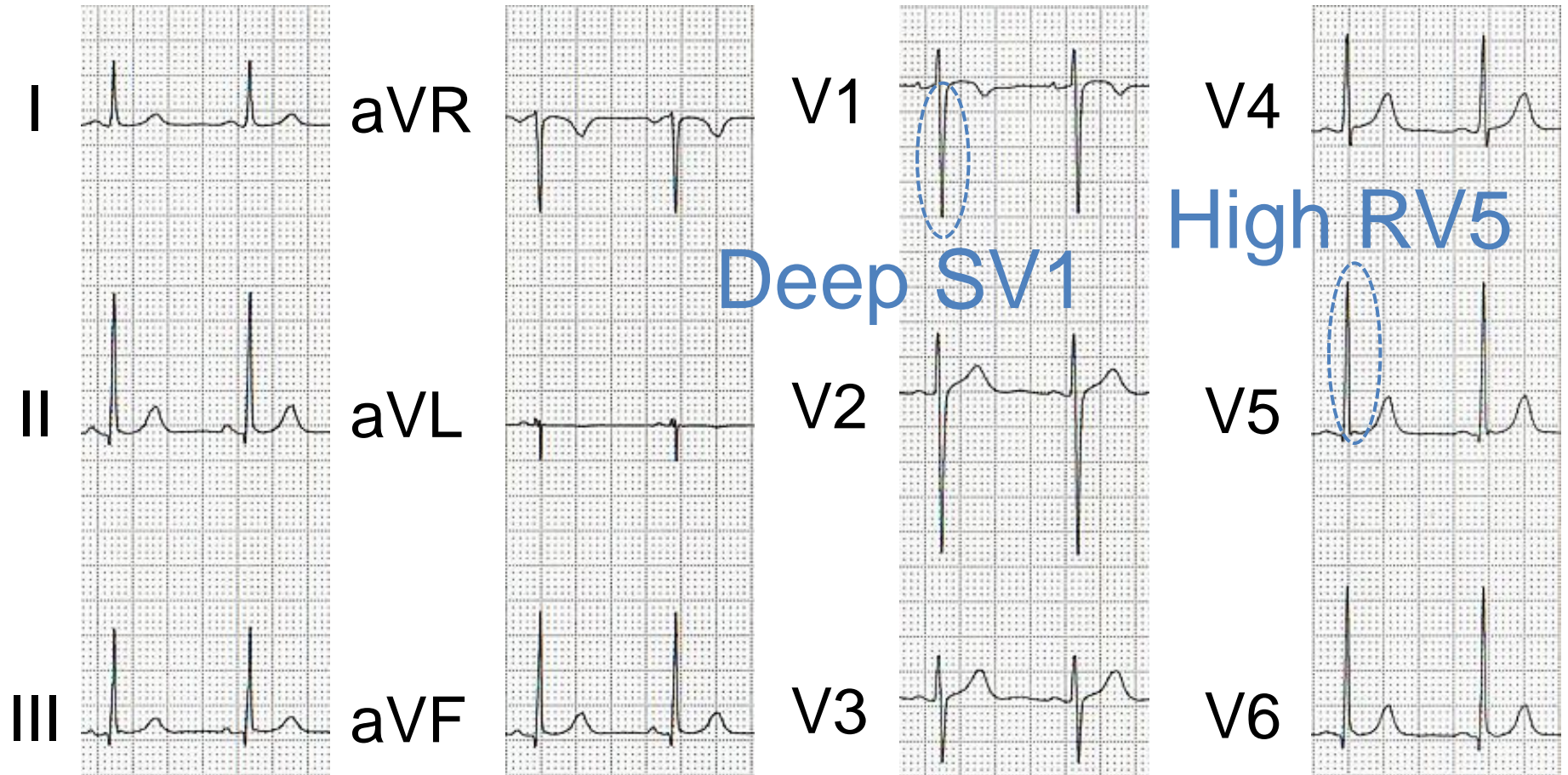
Ventricular septal defect (VSD)

Patent ductus arteriosus (PDA)

Blalock–Taussig shunt

Volume overload

18 y/o F Patent ductus arteriosus



$SV1 + RV5 = 4.0 \text{ mV} \rightarrow \text{LVH}$

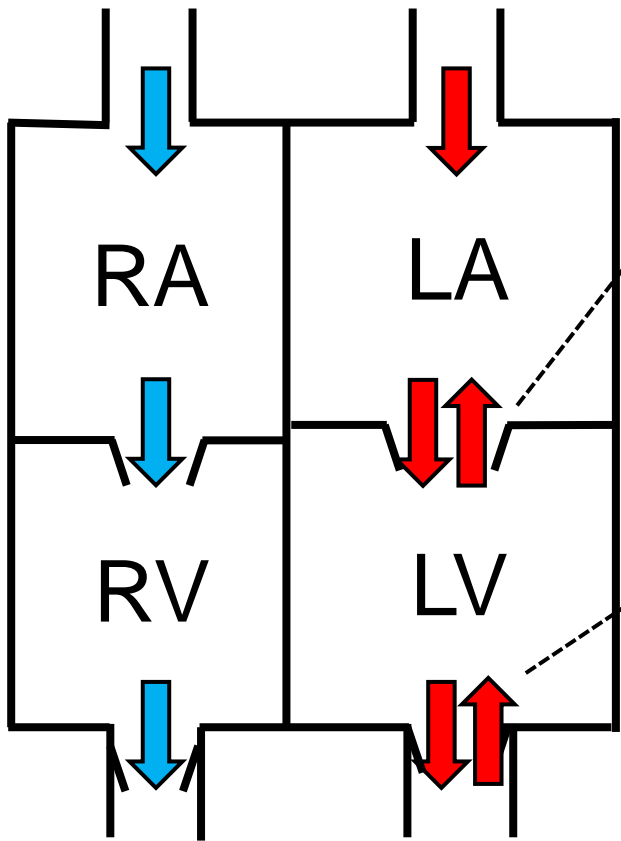
First diagnosed at 18 y/o

Mitral valve
regurgitation
AVSD

Aortic valve
regurgitation

Outlet VSD & coronary
cusp prolapse

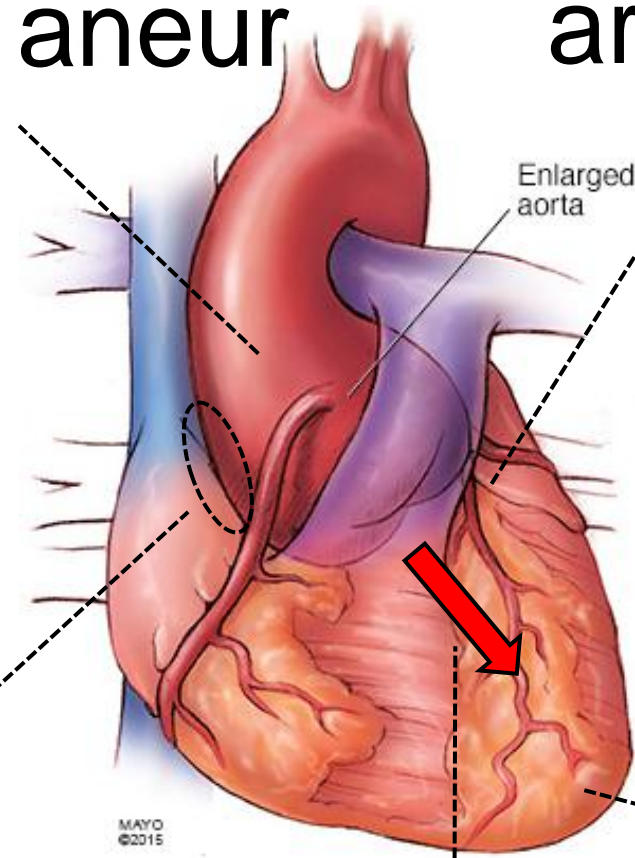
Aortopathy



Volume overload

Aortic dilatation, aneurysm, and dissection

Reduced coronary artery flow



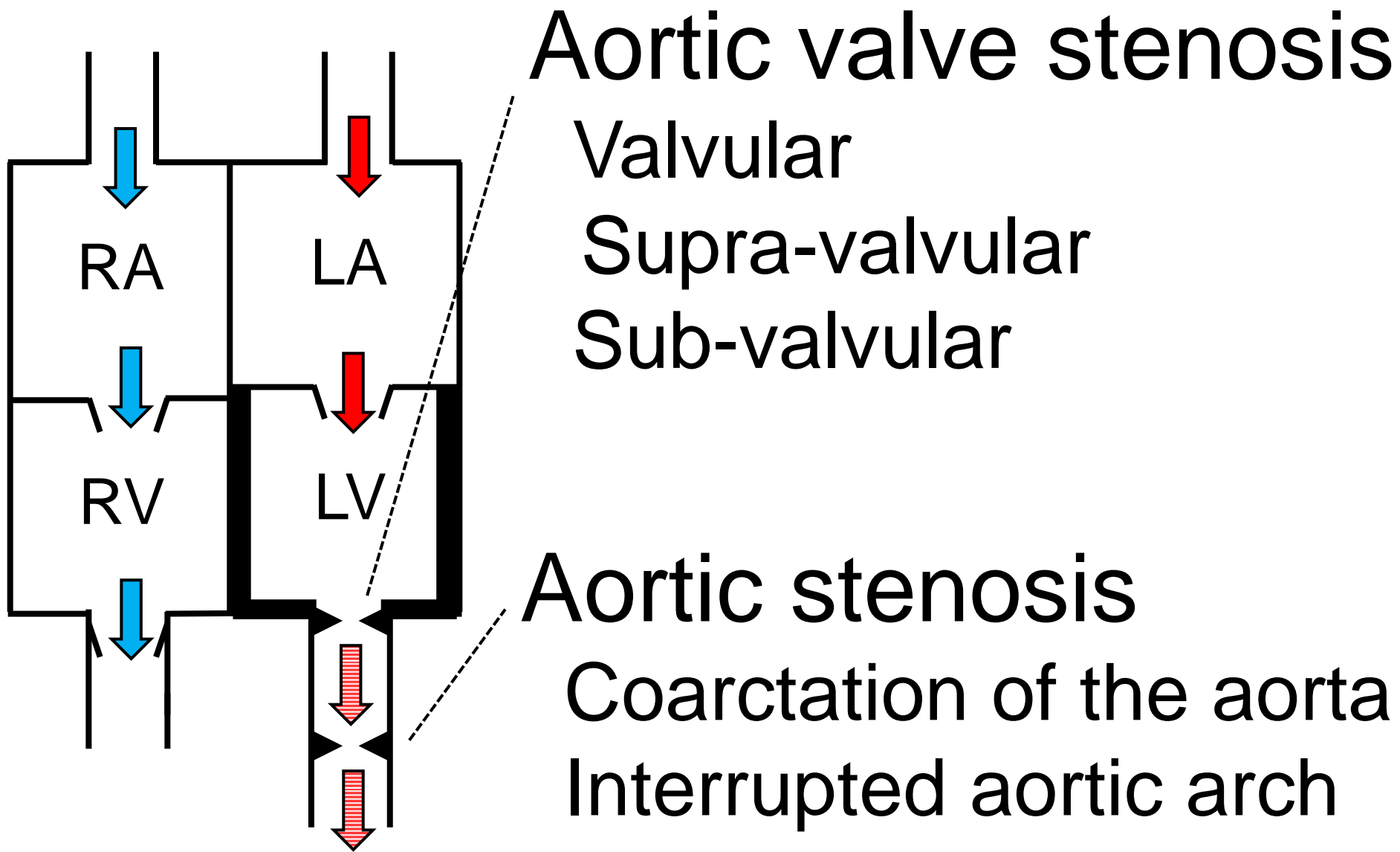
Aortopathy

Increased stiffness due to medial abnormalities

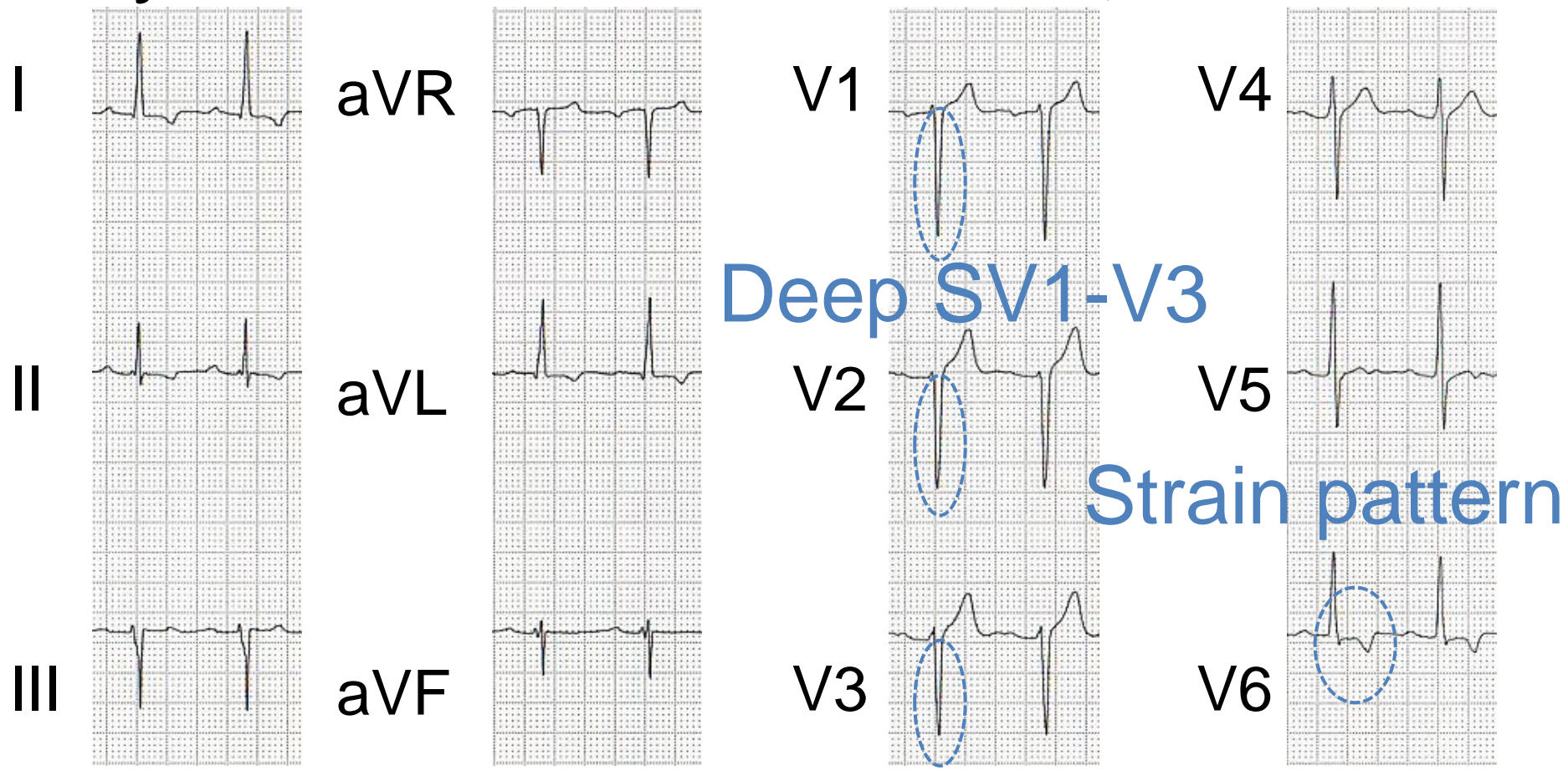
LVH
Aortic regurgitation

Diseases causing aortopathy

- Marfan syndrome
- Turner syndrome
- Bicuspid aortic valve (BAV)
- Tetralogy of Fallot (TOF)
- Single ventricle
- Coarctation of the aorta (COA)
- Persistent truncus arteriosus
- Transposition of the great arteries (TGA)
- Hypoplastic left heart syndrome (HLHS)

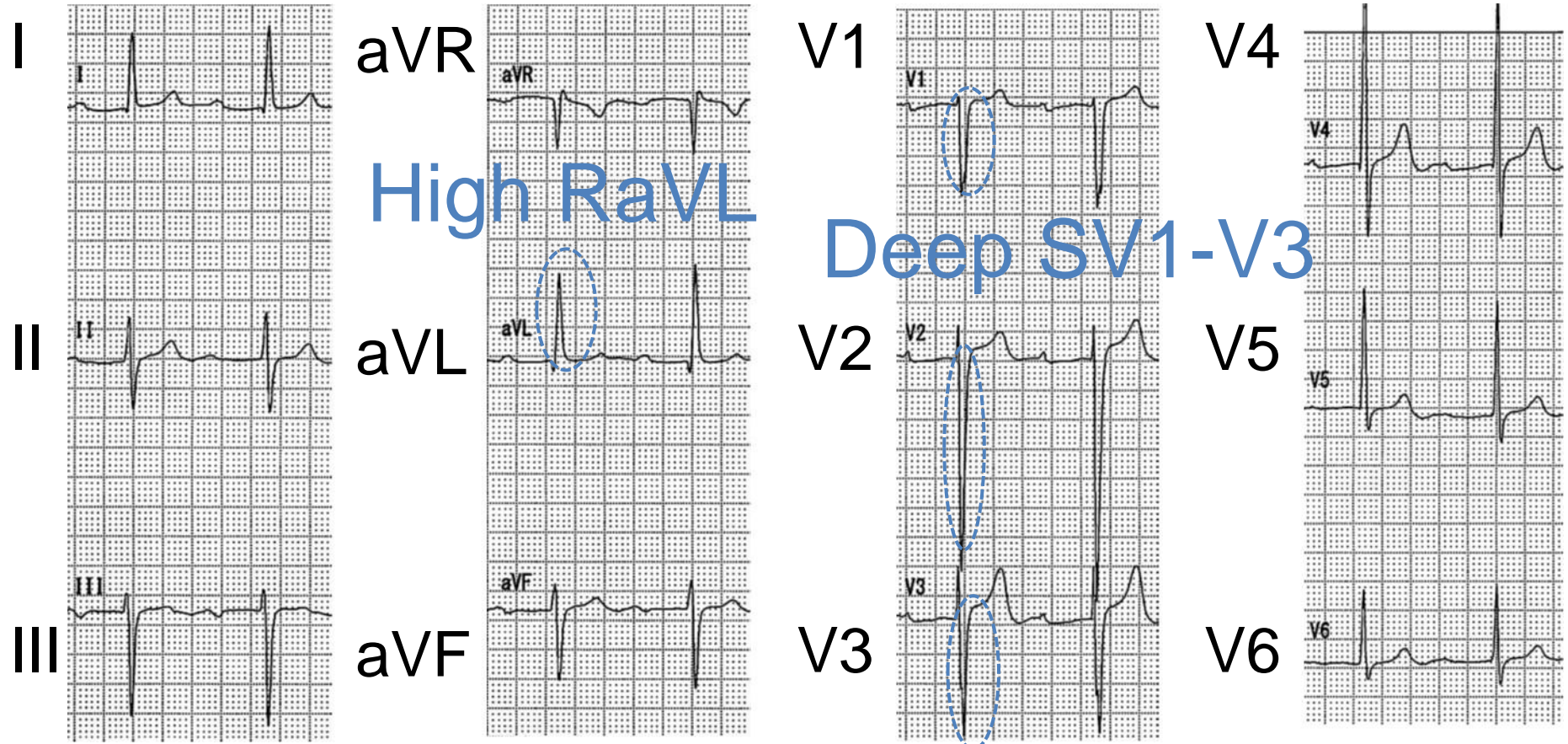


42 y/o M Aortic stenosis, BAV



ST-T changes in I, aVL, and V6 → LVH
Health exam abnormality and dyspnea

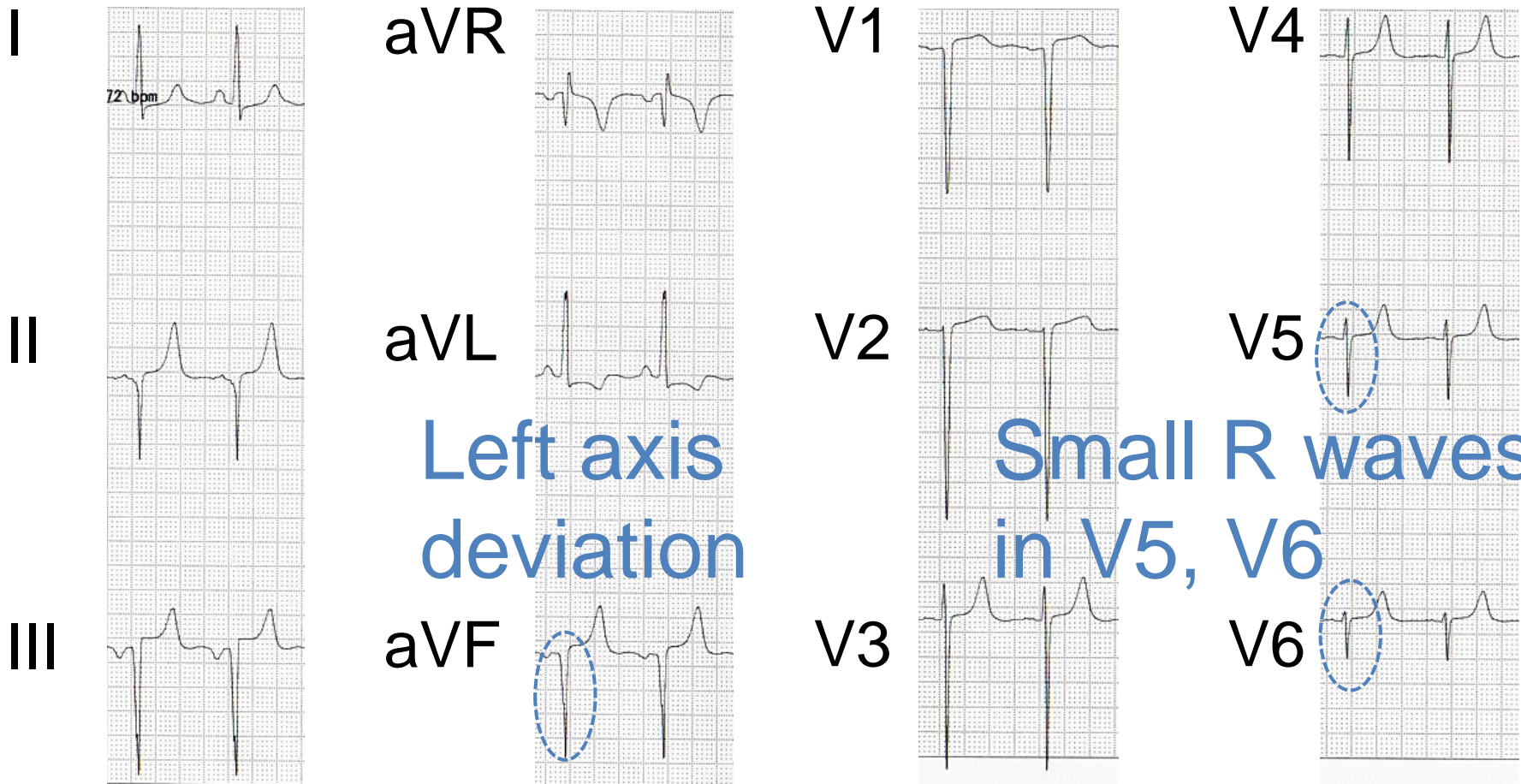
27y/o M Interrupted aortic arch p.o.



$$\text{RaVL} + \text{SV3} = 3.6 \text{ mV} \rightarrow \text{LVH}$$

Hypertension without re-stenosis of aortic arch

20 y/o F HOCM, Noonan synd.



$R_{aVL} + S_{V3} = 7.7 \text{ mV} \rightarrow \text{LVH?}$

Progressive obstruction of LV outflow

ACHD with left axis deviation

AVSD

Tricuspid atresia

Noonan syndrome

Often

Perimembranous VSD

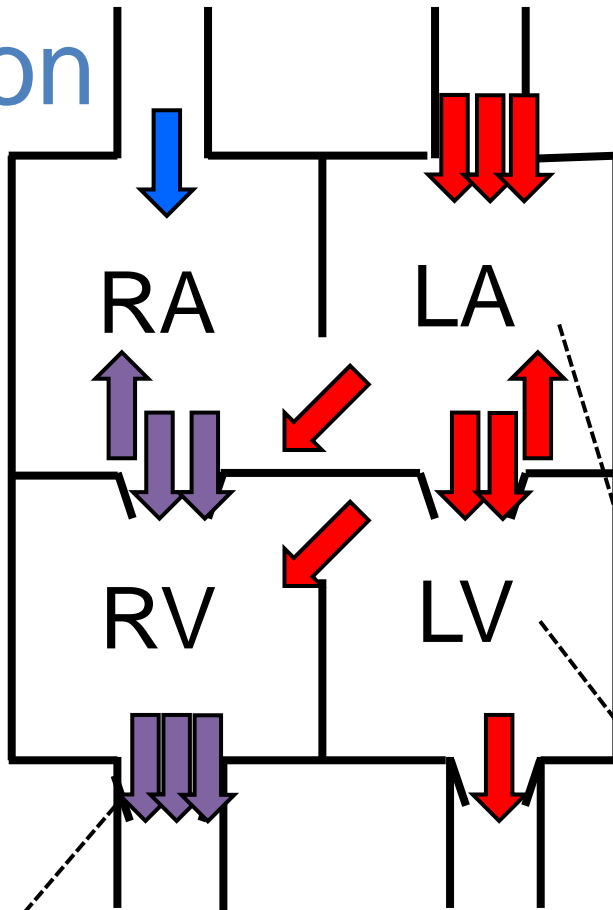
Corrected TGA

Single ventricle

Sometimes

Complete AVSD

Left axis
deviation

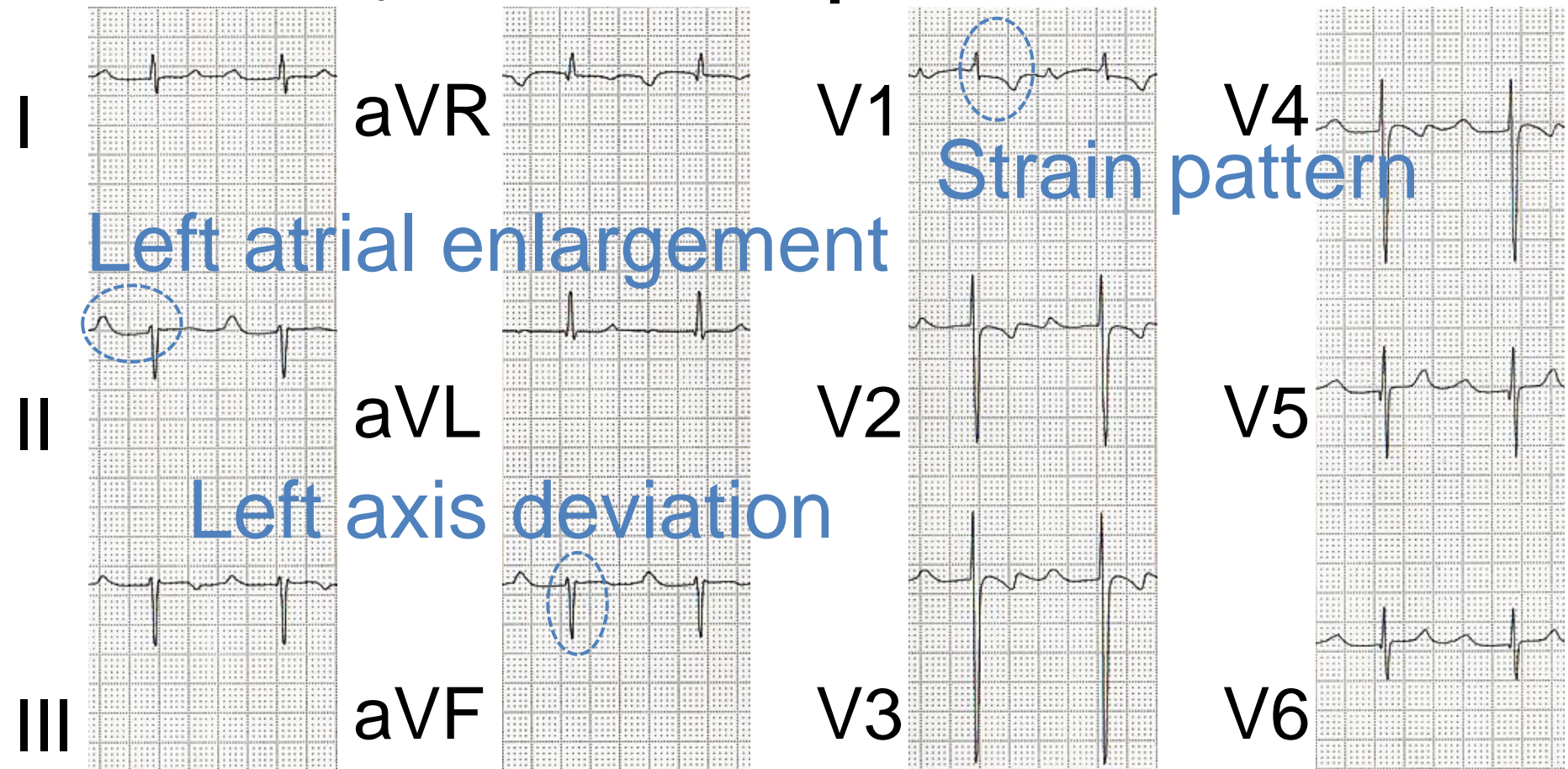


Left-to-right shunt
+
Atrioventricular
valve regurgitation

Volume overload

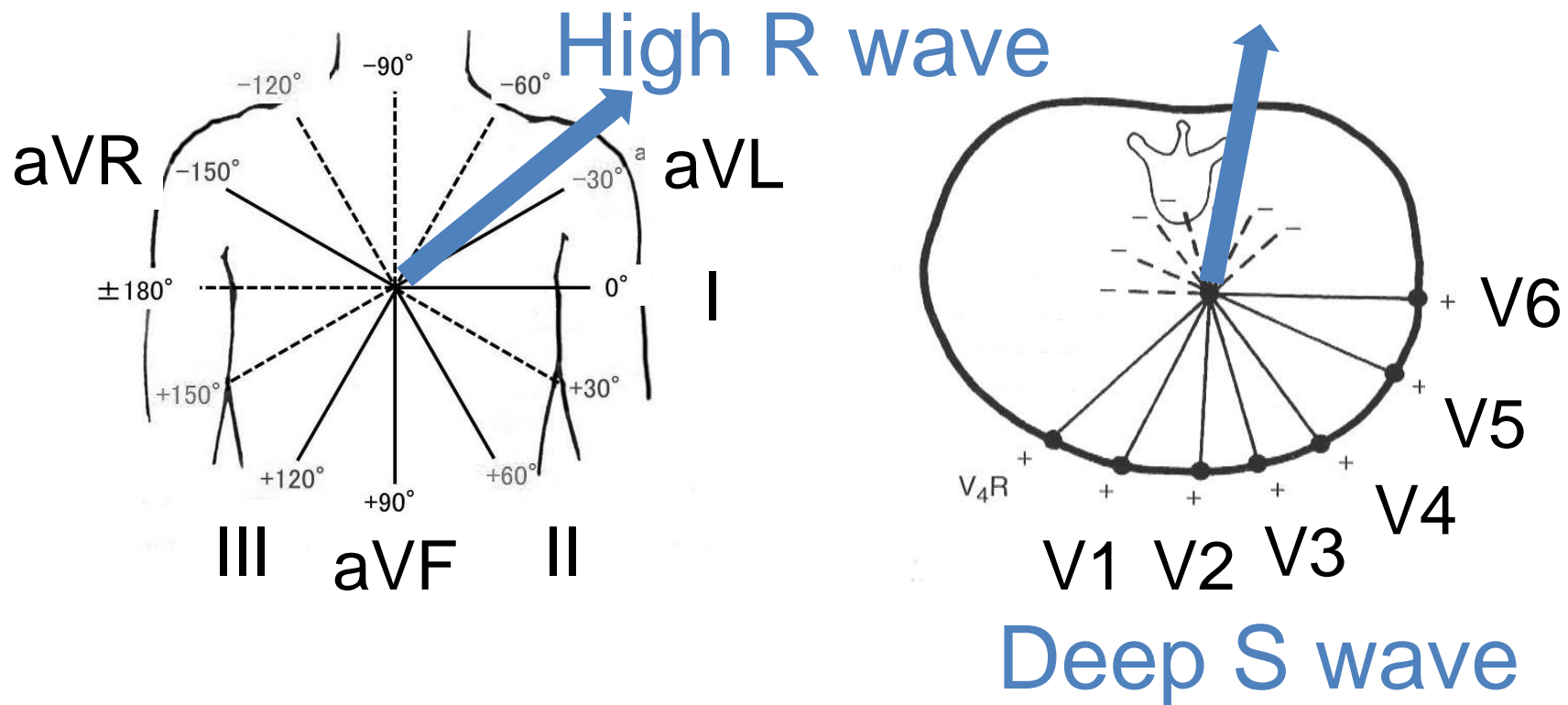
Increased pulmonary blood flow

36 y/o F Complete AVSD



$RaVL + SV3 = 3.7 \text{ mV} \rightarrow \text{LVH?}$

Down syndrome, Mitral valve regurgitation,

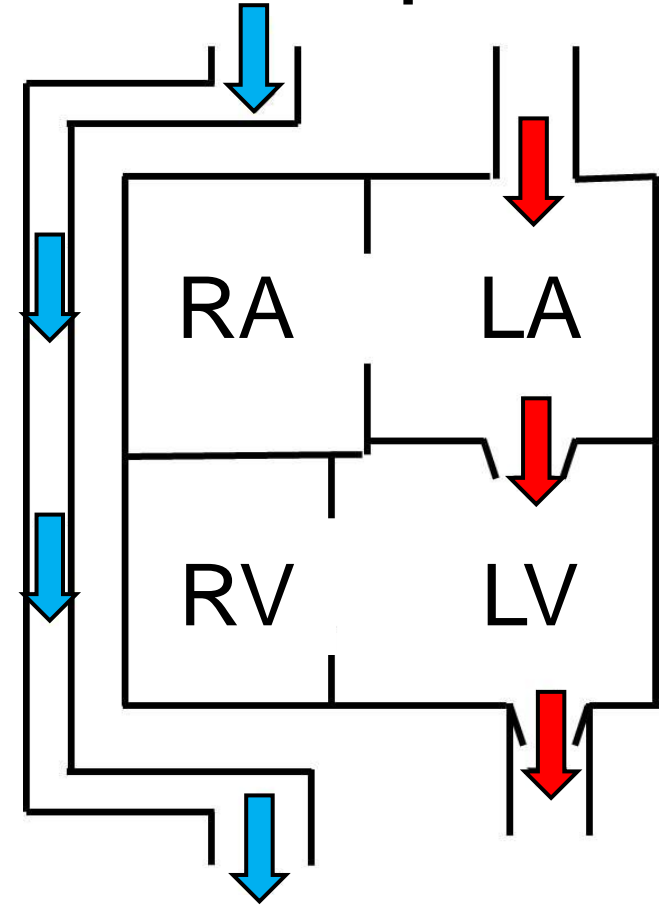
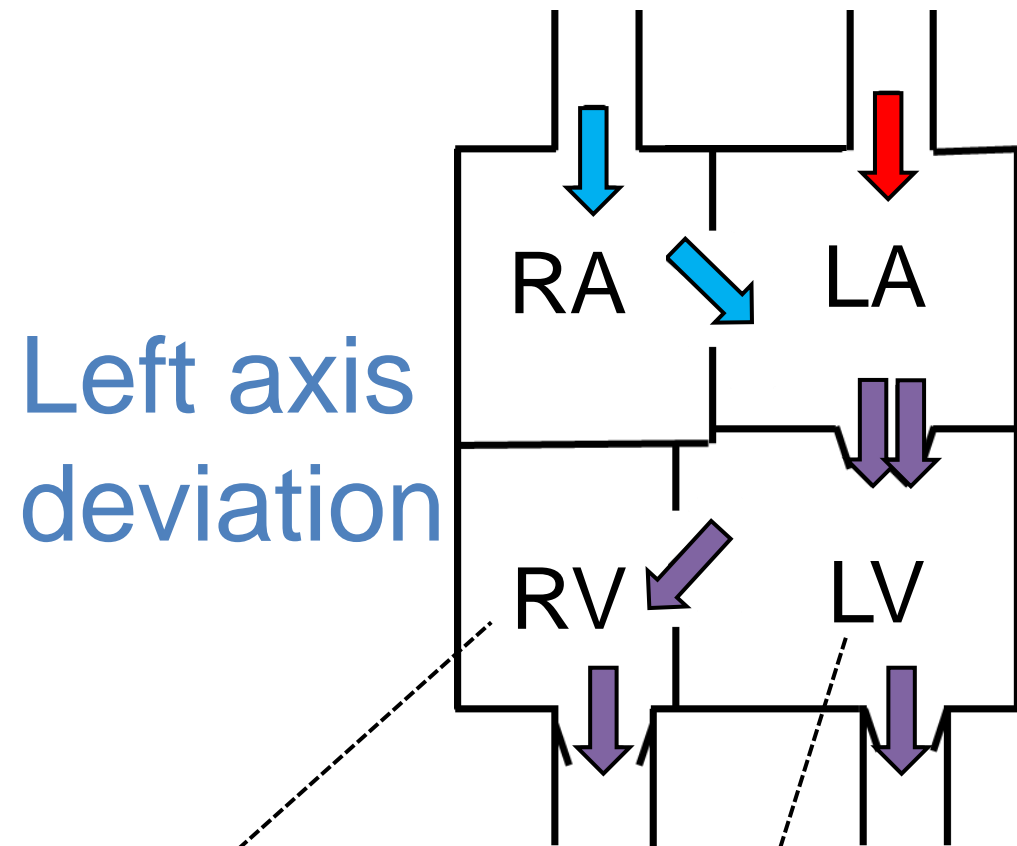


In ACHD with left axis deviation, RaVL is higher. If associated with clockwise rotation, SV1 to SV3 are deeper.

Voltage criteria may **NOT** be applied.

Tricuspid atresia

Fontan operation

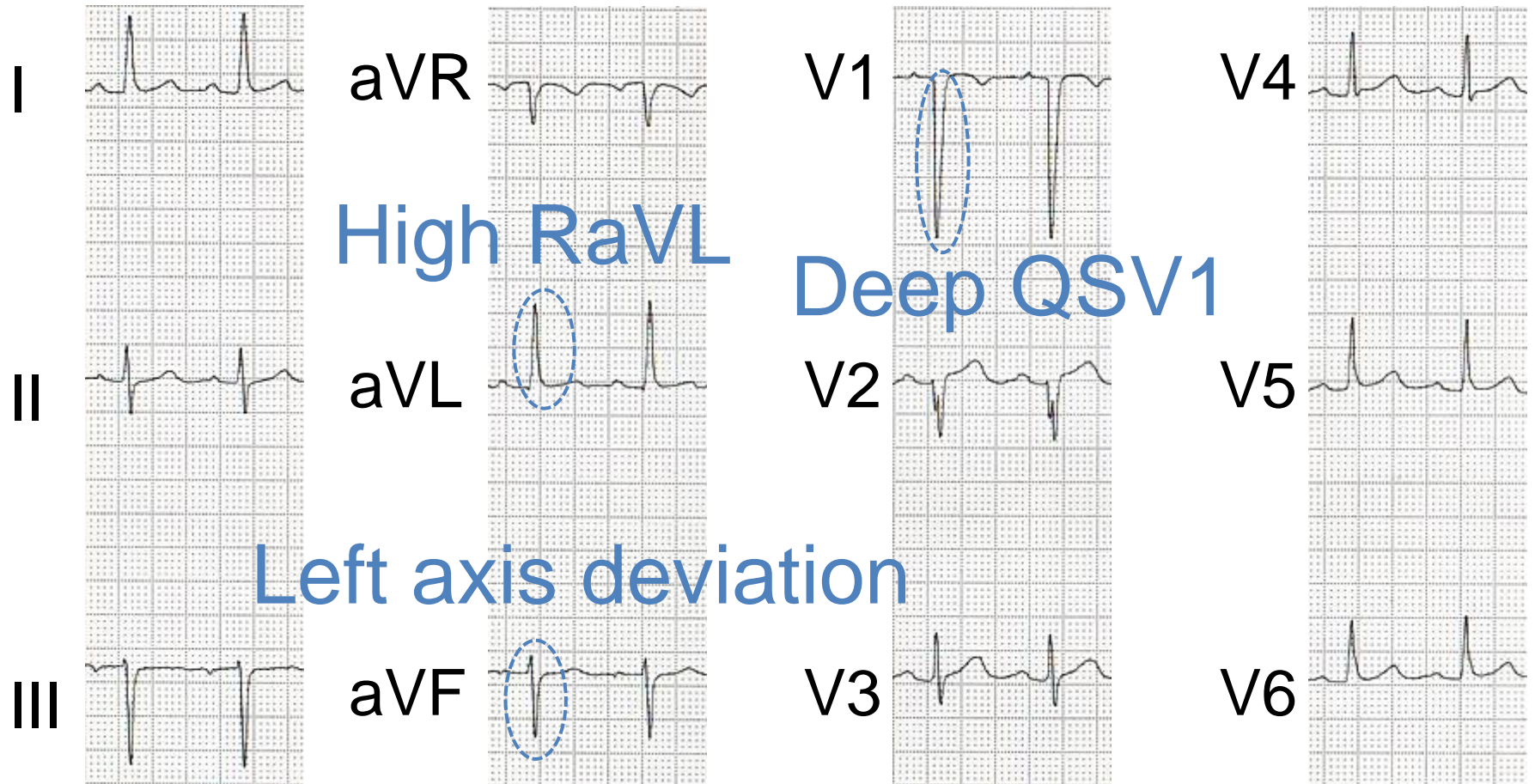


Left axis deviation

Hypoplasia

Volume overload

20 y/o F Tricuspid atresia p.o.



$RV5 + SV1 = 3.5 \text{ mV} \rightarrow \text{LVH?}$

Good course after Fontan operation

Take home messages

- 1) LVH is induced by several ACHD including aortopathy.
- 2) ECG is useful for evaluating cardiac load on LV in ACHD.
- 3) Criteria for LVH and the clinical impact for ACHD should be investigated.