PROMINENT QRS ANTERIOR FORCES
FUERZAS ANTERIORES PROMINENTES
FORÇAS ANTERIORES PROEMINENTES

Presentation: Andrés Ricardo Pérez-Riera M.D. Ph.D.
Chief of electro-vectorcardiographic sector- Cardiology Discipline – ABC Faculty – ABC Foundation – São Paulo – Brazil.
riera@uol.com.br

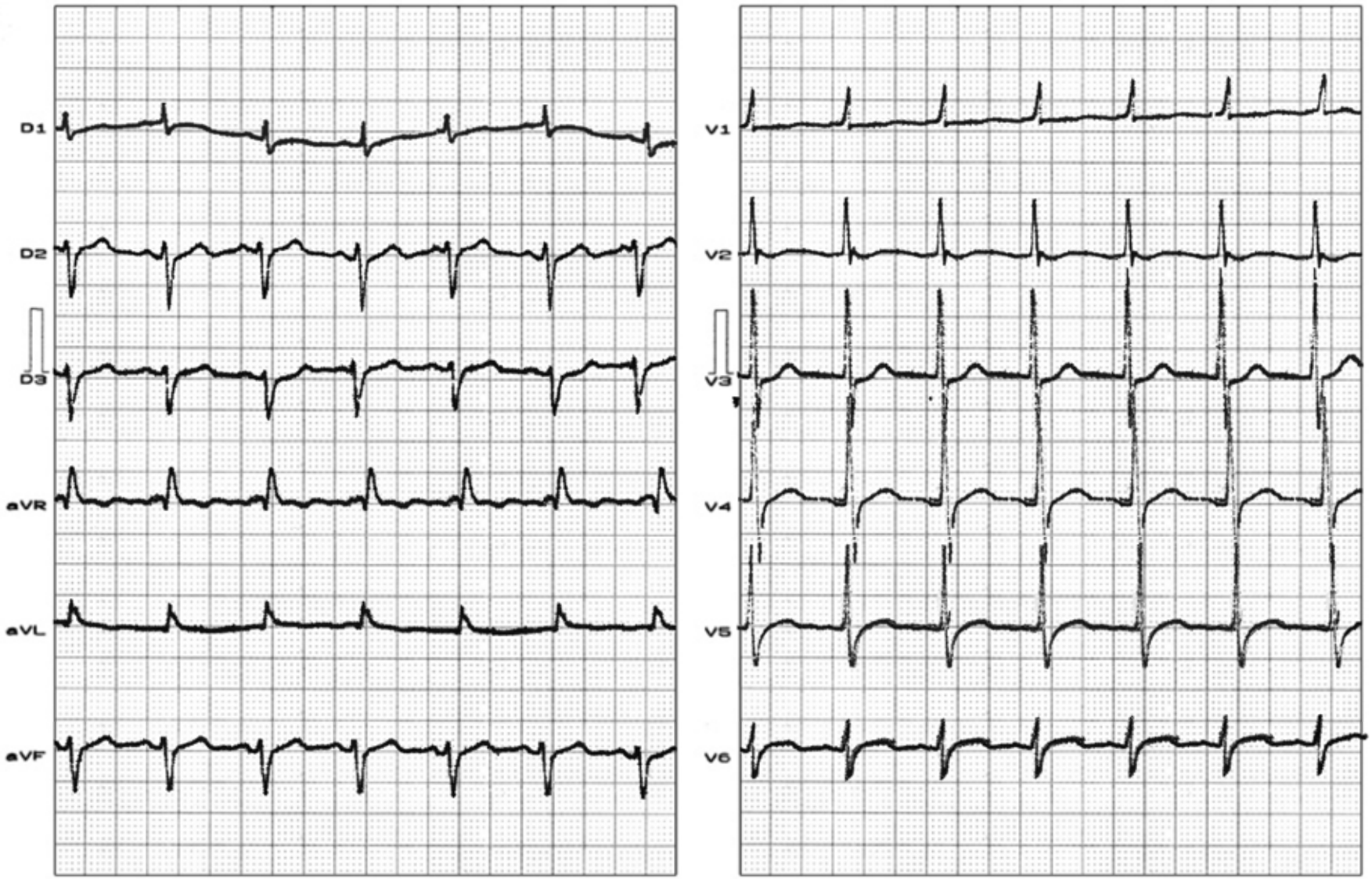
These ECG/VCG were obtained for a 45-year-old Caucasian male with severe congestive heart failure consequence of idiopathic cardiomyopathy.

Questions:

Which is the cause of Prominent Anterior QRS Forces (PAF)?
And Why?
Differential diagnosis?
It could make the description of the ECG/VCG?

Estos ECG/VCG fueron realizados en un hombre blanco con severa ICC secundária a cardiomiopatia dilatada idiopática.
Preguntas

Cual es la causa de las fuerzas anteriores prominentes del QRS?
Y porque?
Cual es el diagnóstico diferencial?
Podria hacer una descripción del ECG/VCG?

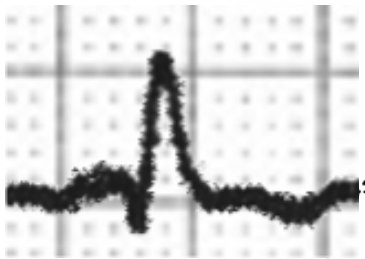

D1
D2
D3
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6

ECG/VCG CORRELATION FRONTAL PLANE

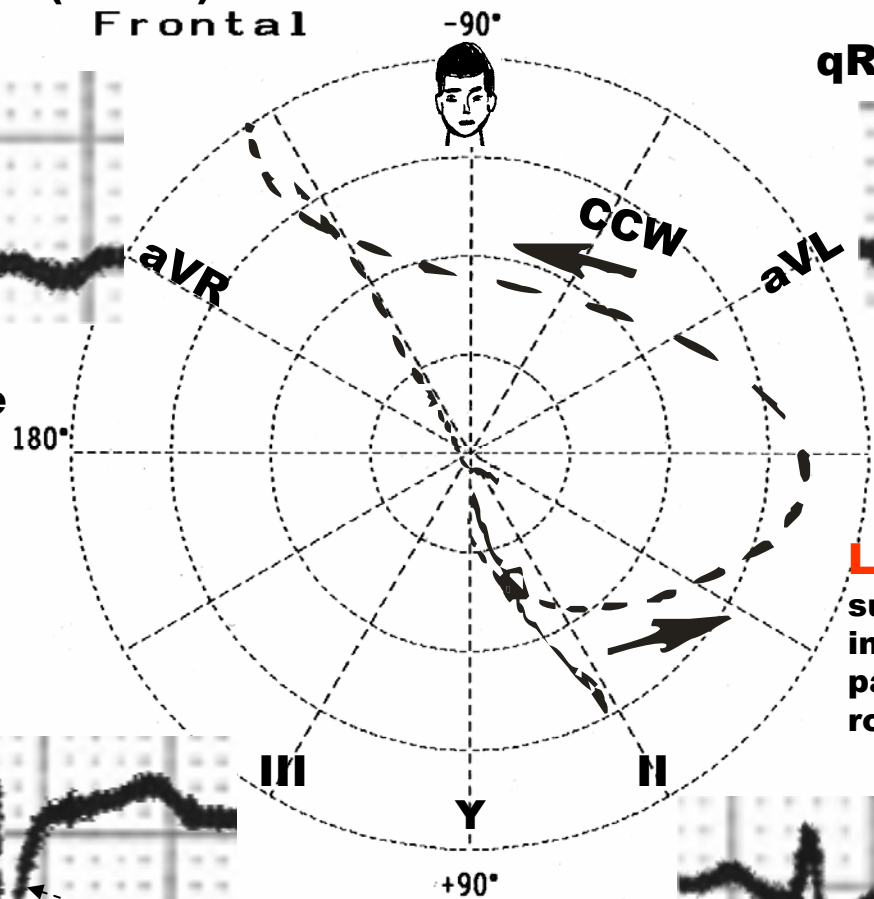
QRS axis near -90º: extreme superior deviation

R wave of aVR ≥ 5 mm (RVOT)

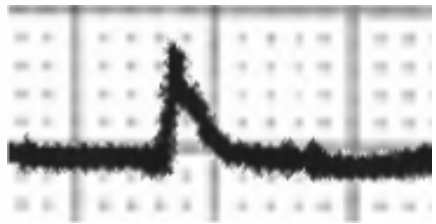
RVH

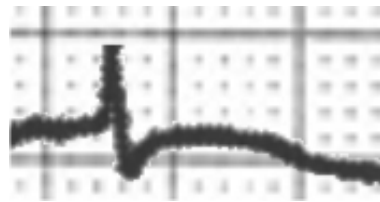


Q/R ratio of aVR ≤ 1:
Q/q ≤ than the R wave



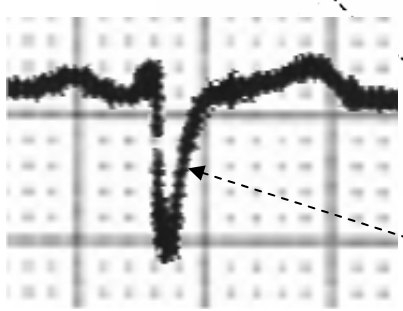
qR in aVL: CCW rotation

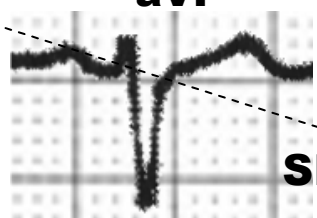


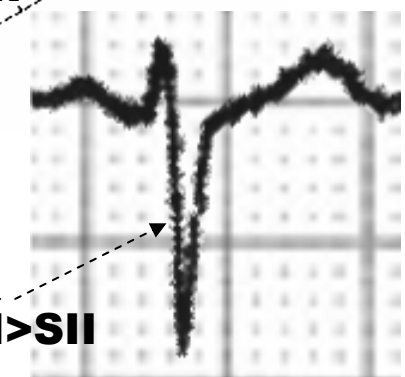


LAFB: **Extreme QRS axis superior deviation, rS pattern in inferior leads, SII>SII, qR pattern in aVL and CCW rotation of QRS loop on FP**

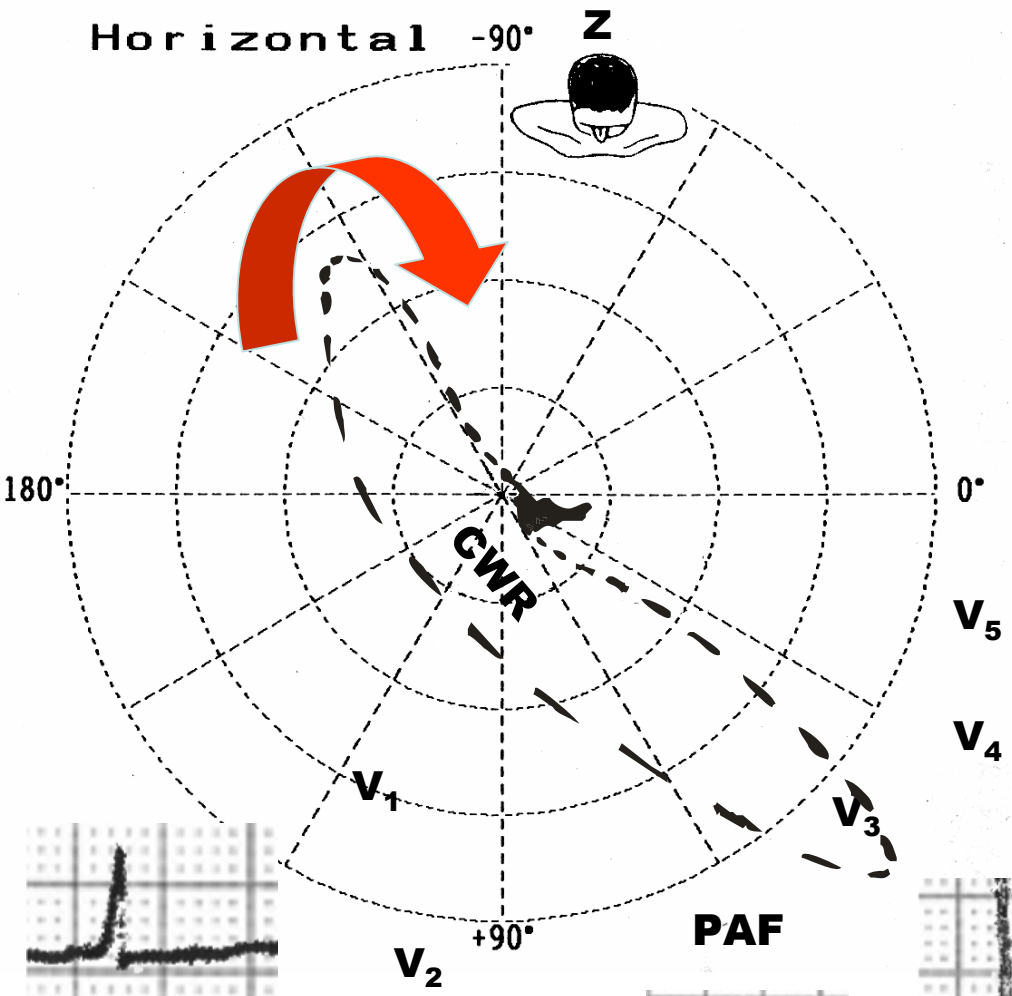
rS pattern in inferior leads







ECG/VCG CORRELATION HORIZONTAL PLANE



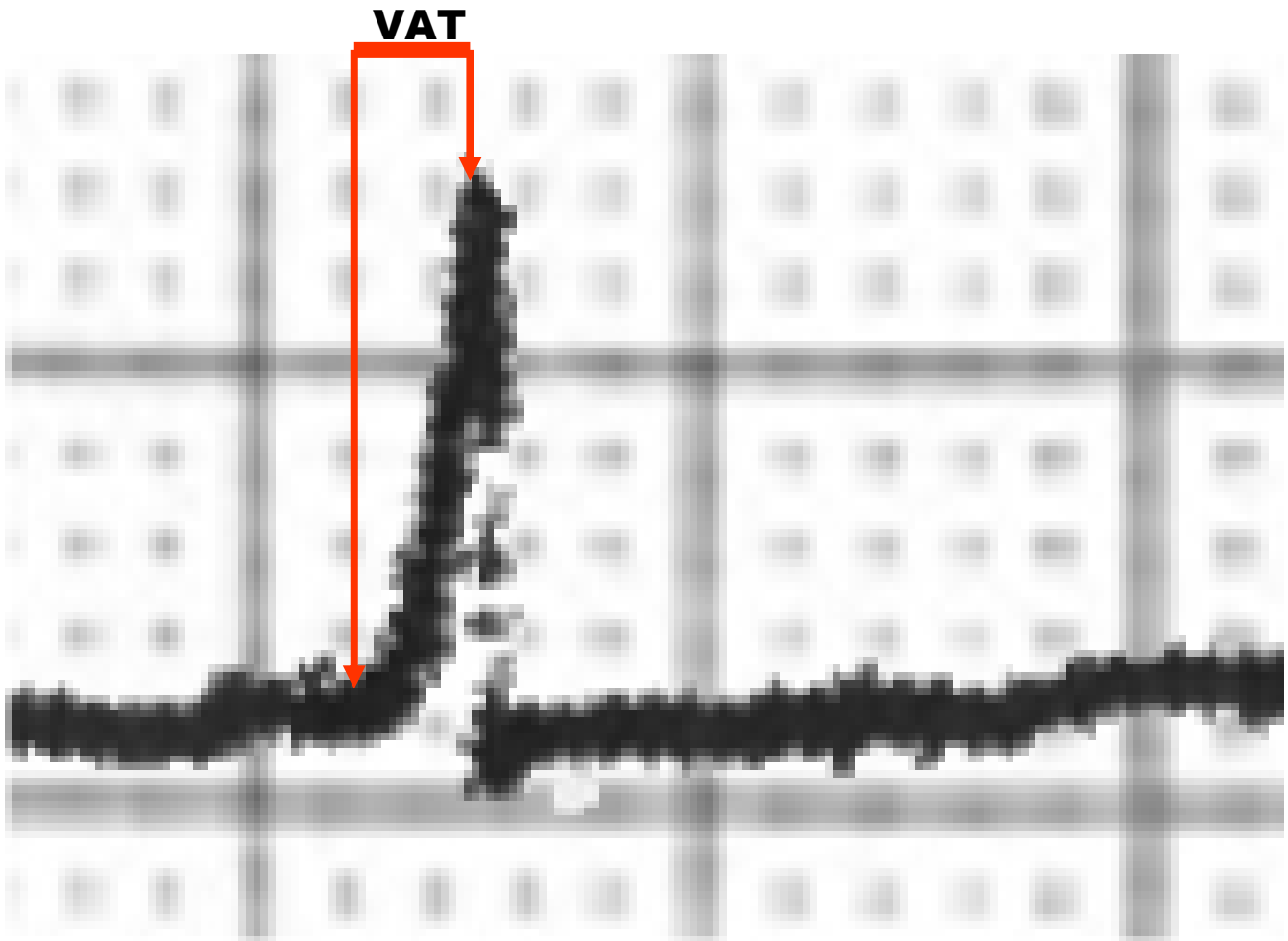
R/S ratio in V6 ≥ 1.

R wave of V_1 > R wave of V_6 (it indicates severe RVH or RVE).

R wave of V_1 and V_2, > 7 mm

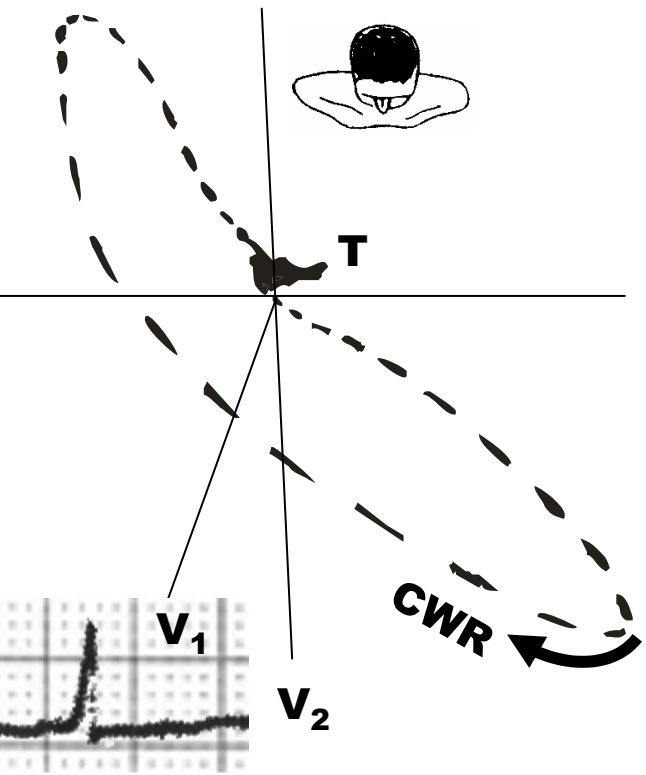
S wave of V_1 < 2 mm

R wave of V_1 + S wave of V_5 and/or V_6 ≥10.5 mm (Sokolow-Lyon index for the RVH).



Ventricular Activation Time (**VAT**), greater than 40 ms in V_1 ⇨ Right Ventricular Hypertrophy or Enlargement (RVH or RVE)

TYPE A or I RIGHT VENTRICULAR HYPERTROPHY or ENLARGEMENT



QRS loop with clockwise rotation (**CWR**) in the horizontal plane and predominantly localized in anterior quadrants. It inversion QRS rotation indicates severe RVH or RVE.

Initial forces are preserved with convexity to the right and to the front. If the initial 20ms forces are directed backward and to the left, indicating more severity with clockwise rotation of the septum by clockwise rotation of the heart in the longitudinal axis, when observed from the apex. The phenomenon indicates supra-systemic right intraventricular pressure.

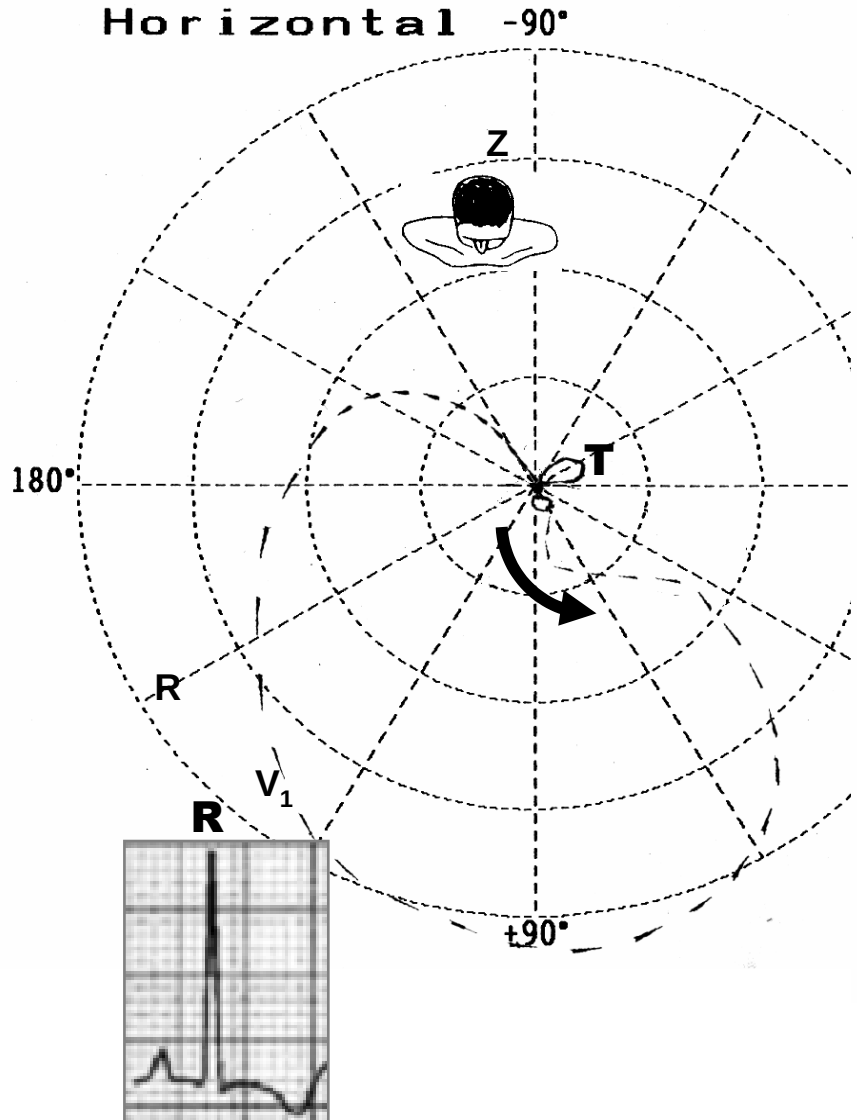
The complexes of initial negativity in V1 or V1 and V2 are known as sign of Sodi. There is no significant end conduction delay.

ST/T vector: heading to the back and the left. ST convex to the top and T wave opposite to the greatest QRS deflection in the leads located in front of the RV: V_1, V_2, V_3R and V_4R.

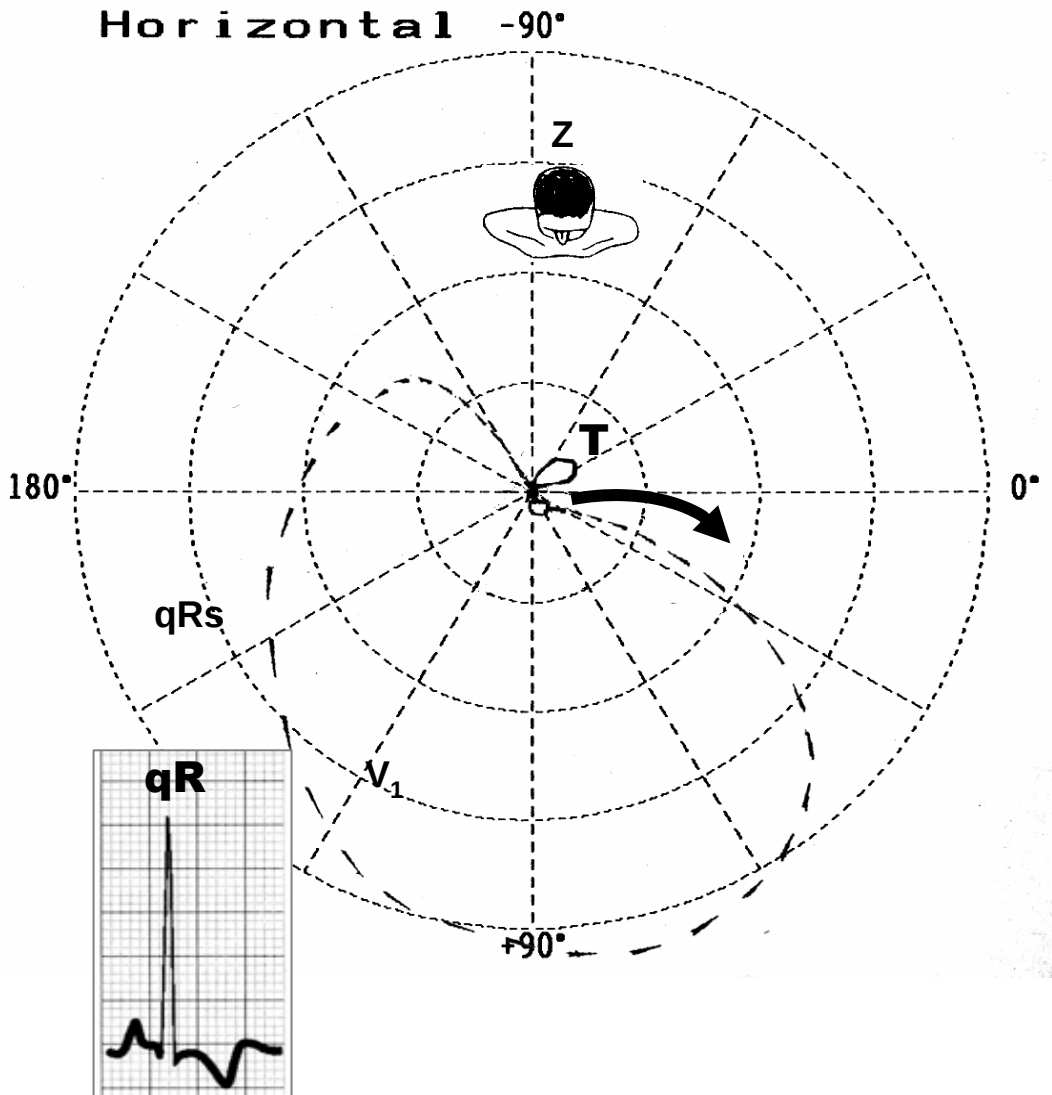
CRITERIA OF RIGHT VENTRICULAR ENLARGEMENT BY THE CHARACTERISTICS OF VECTOCARDIOGRAPHIC QRS LOOP IN THE HORIZONTAL PLANE

RVH or RVE TYPE A or I

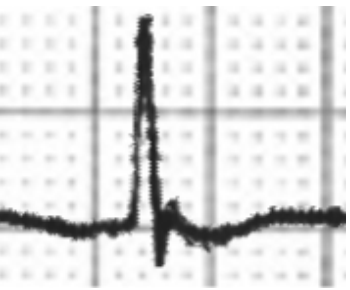
SEVERE SVD



EXTREME SVD

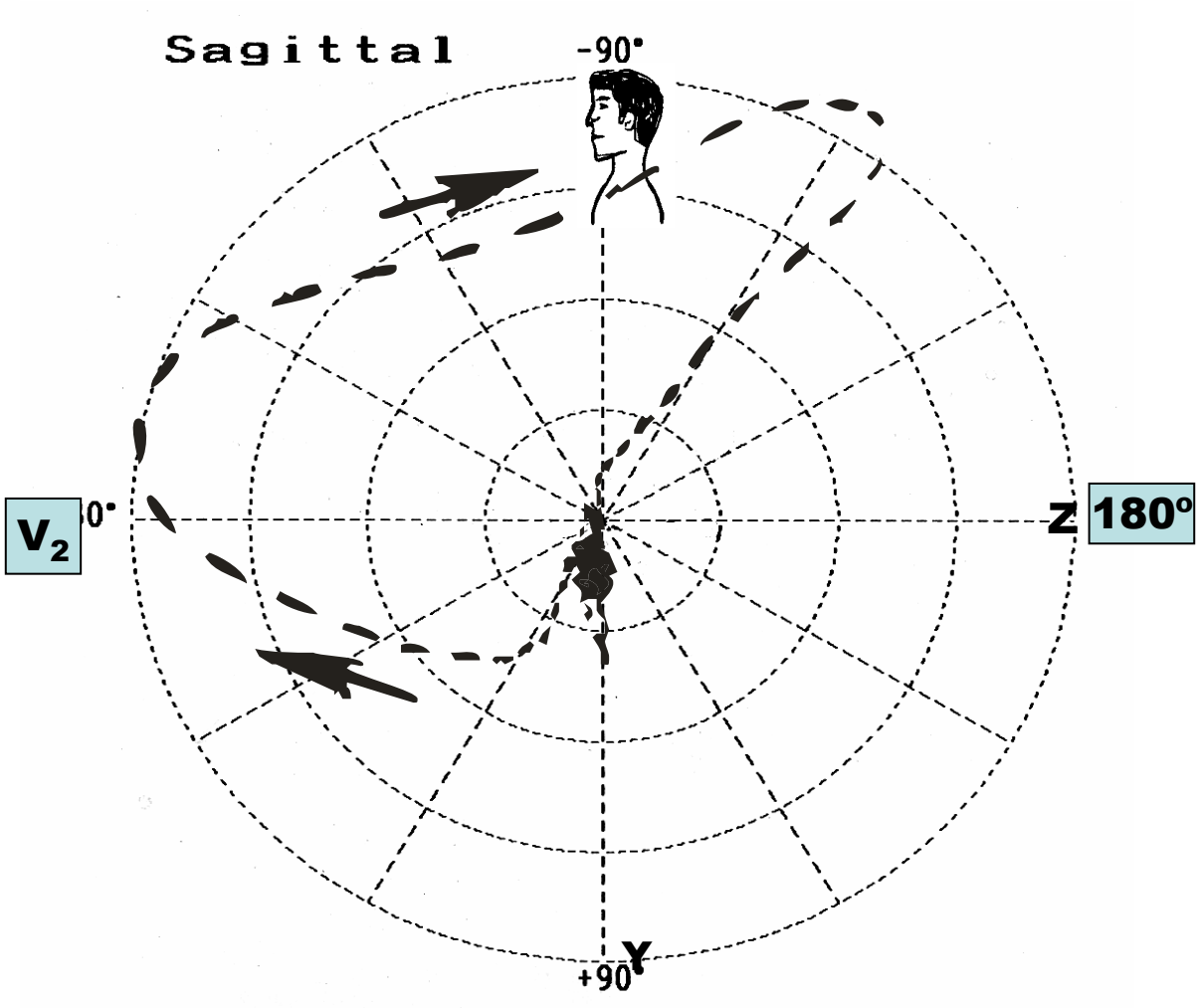


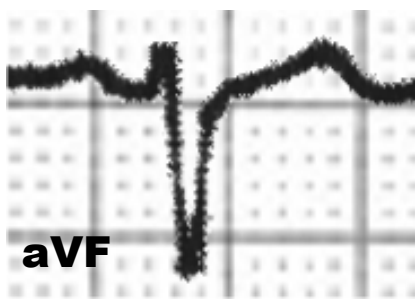
ECG/VCG CORRELATION LEFT SAGGITAL PLANE



V_2

PROMINENT ANTERIOR QRS FORCES (PAF)





aVF

RIGHT VENTRICLE HYPERTROPHY (RVH) OR RIGHT VENTRICULAR ENLARGEMENT MAIN VCG FEATURES

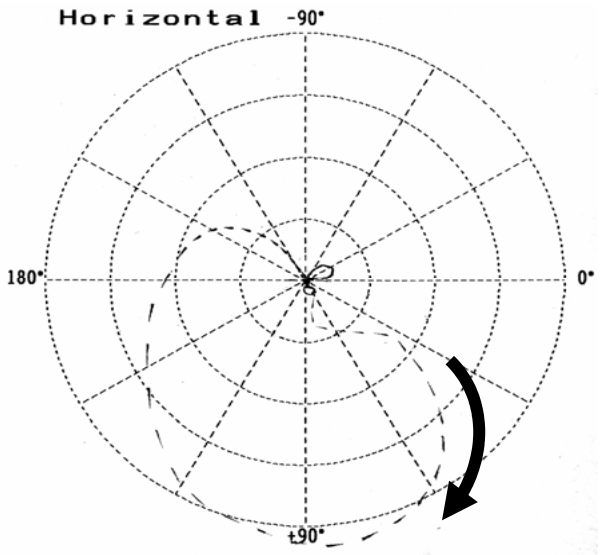
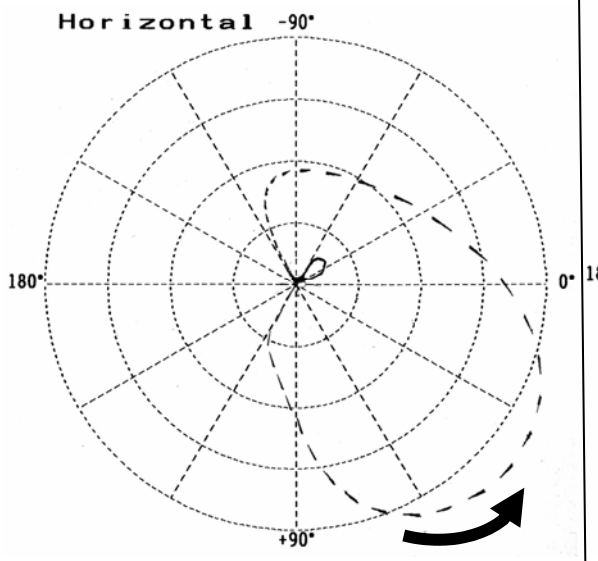
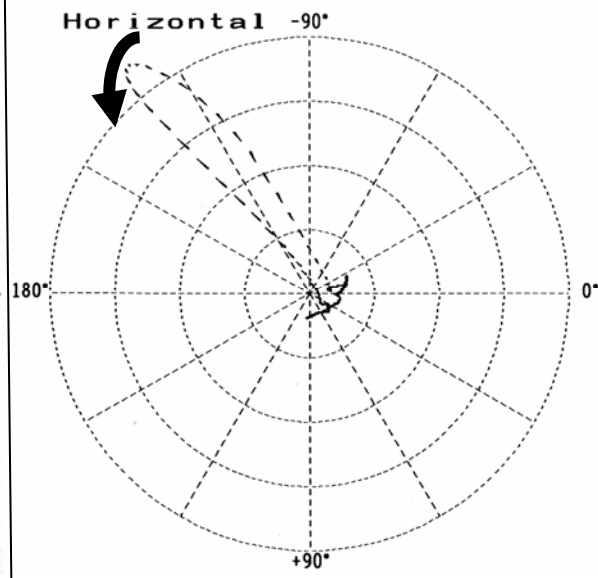
VECTORCARDIOGRAPHIC TYPES OF RIGHT VENTRICULAR HYPERTROPHY(RVH) OR RIGHT VENTRICULAR ENLARGEMENT(RVE)

- **VCG CLASSIFICATION OF RVH**
  - Type A or I
  - Type B or II
  - Type C, III or Special
  - Type D or IV (it is not universally considered)

- **RELATED TO SEVERITY**
  - Mild
  - Moderate
  - Severe
  - Extreme

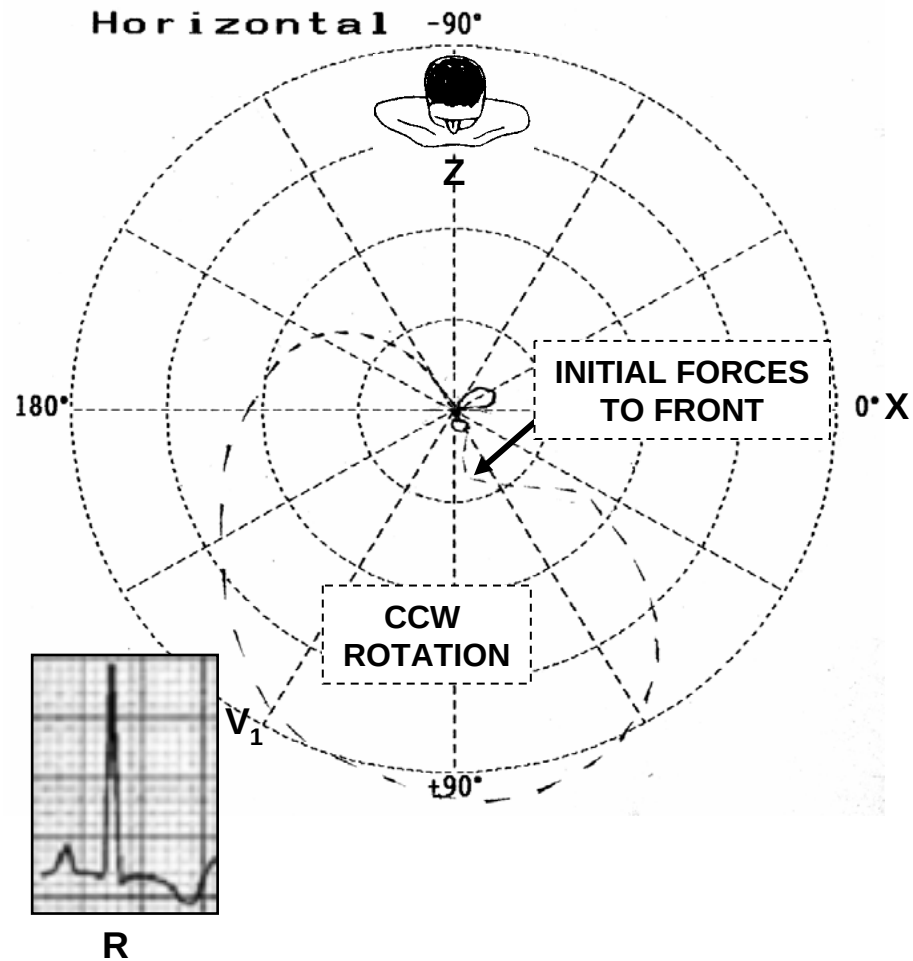
Types of right ventricular hypertrophy by severity, most affected RV region, and by the vectorcardiographic loop in the horizontal plane (HP).

VECTORCARDIOGRAPHIC TYPES OF RIGHT VENTRICULAR HYPERTROPHY

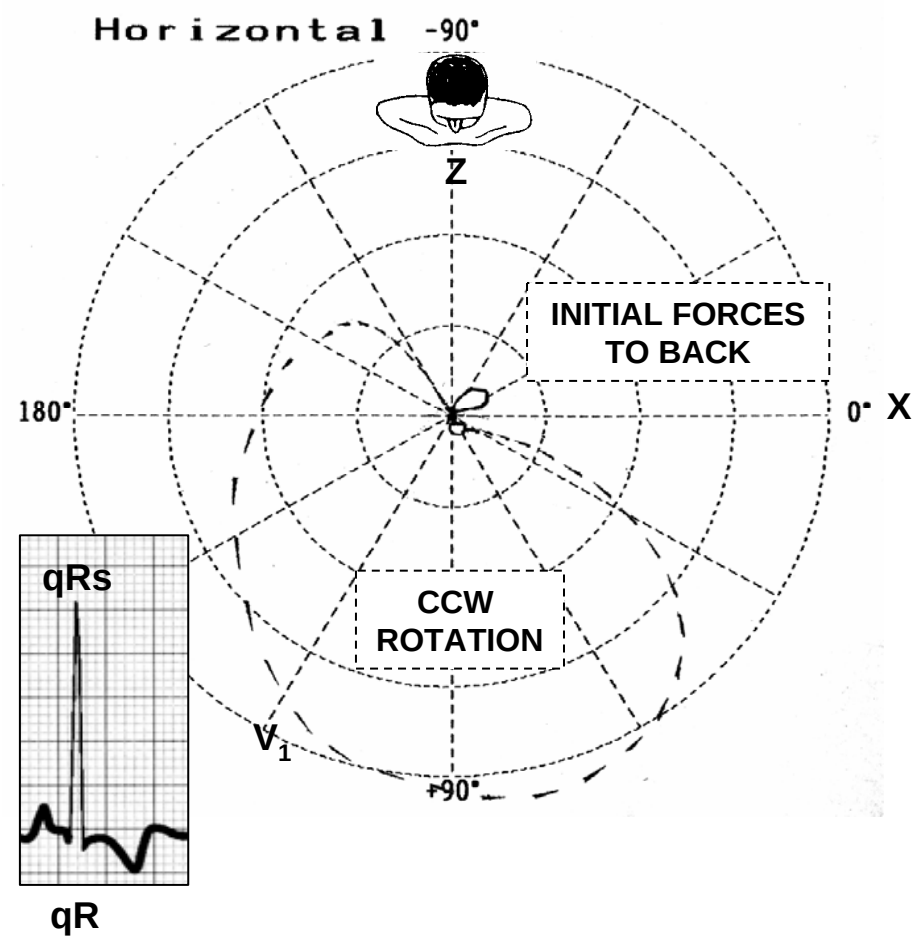
	TYPE A	TYPE B	TYPE C OR SPECIAL
			
QRS rotation	Counter Clock Wise	Clock Wise or figure in eight	Counter Clock wise or rotation in eight
QRS location	≥70% of the area of the QRS loop in anterior quadrants	≥70% of the area of the QRS loop in anterior quadrants	More than 70% of the area of the loop in posterior quadrants and more than 20% of in the right posterior one.

RVH TYPE A or I

SEVERE RVH

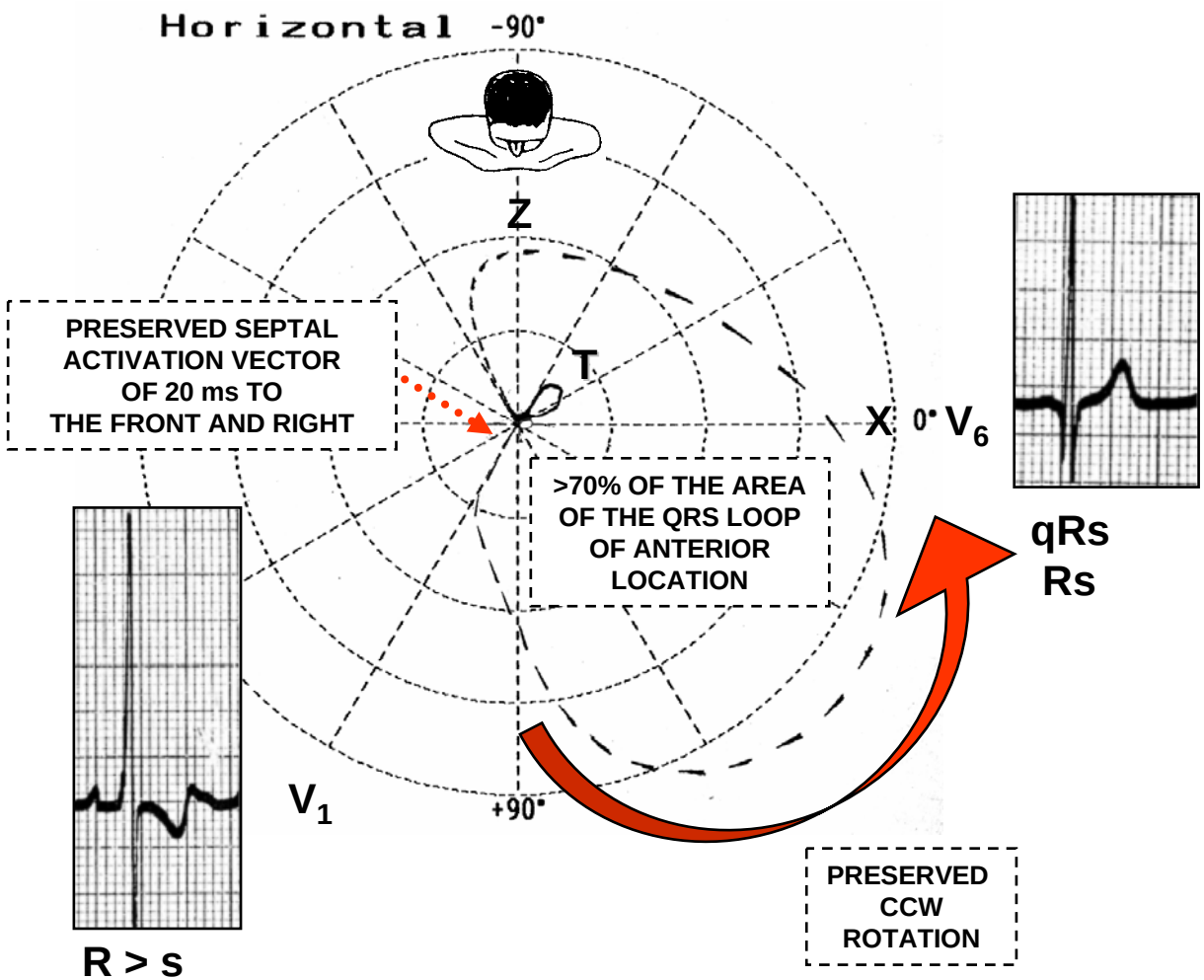


EXTREME RVH



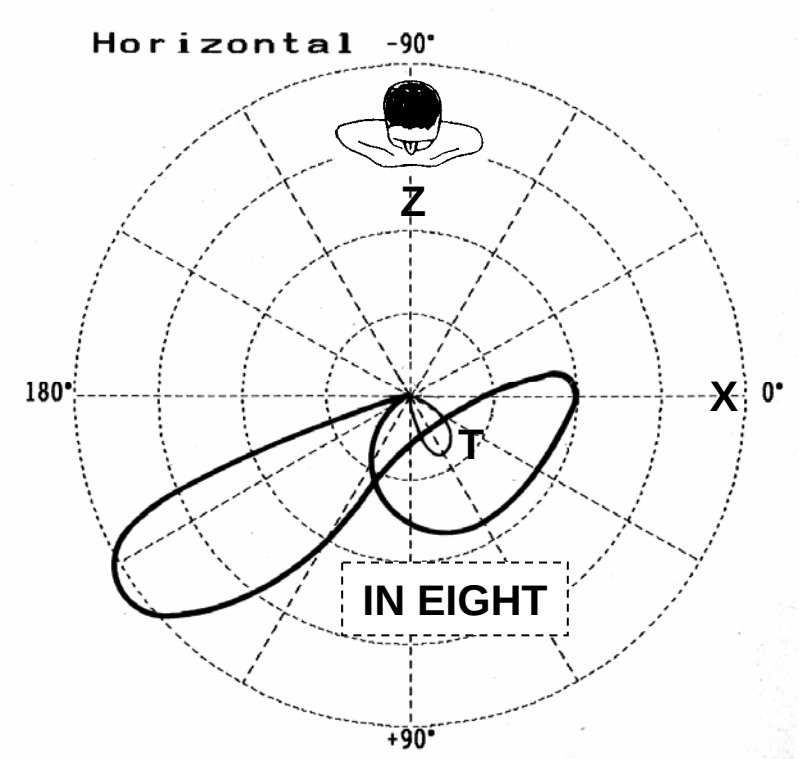
Vectorcardiographic loops in the HP in RVH type A or I. CCW rotation located predominantly on right anterior quadrant

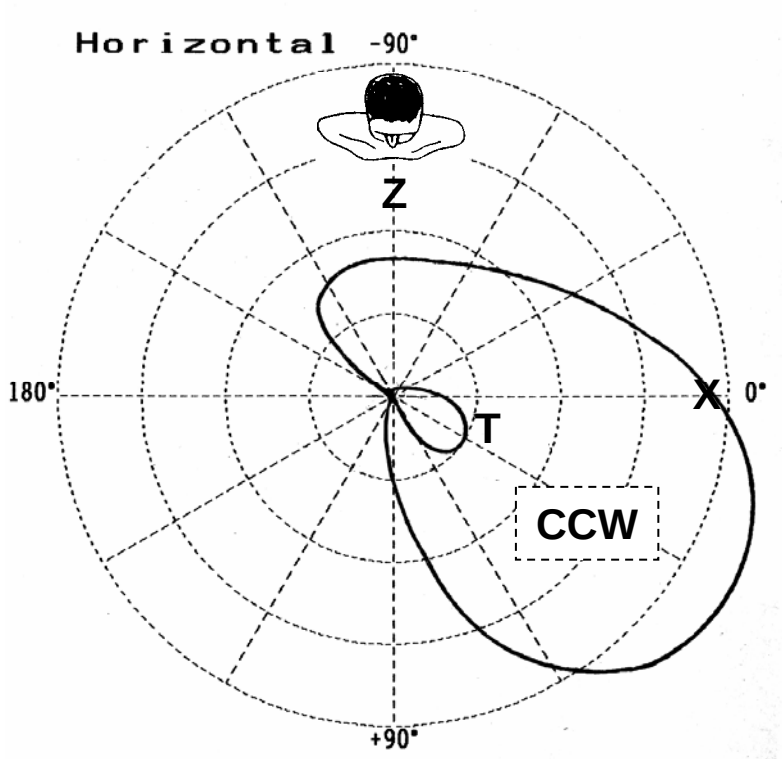
RVH TYPE B or II



ECG/VCG correlation in the HP in RVH vectorcardiographic type B or II.

RVH TYPE B or II MODALITIES

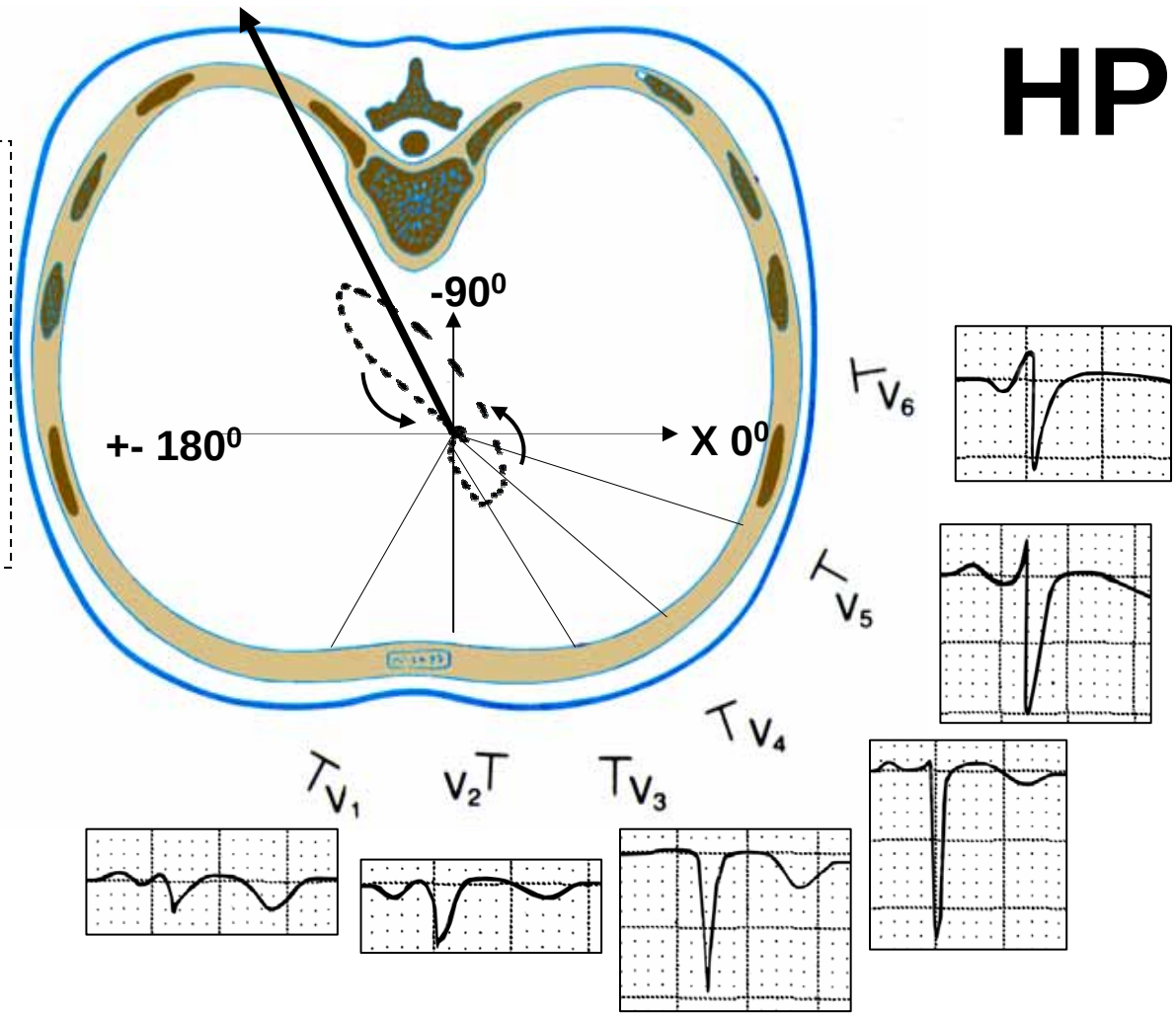




ECG/VCG correlation in the HP in RVH vectorcardiographic type B or II.

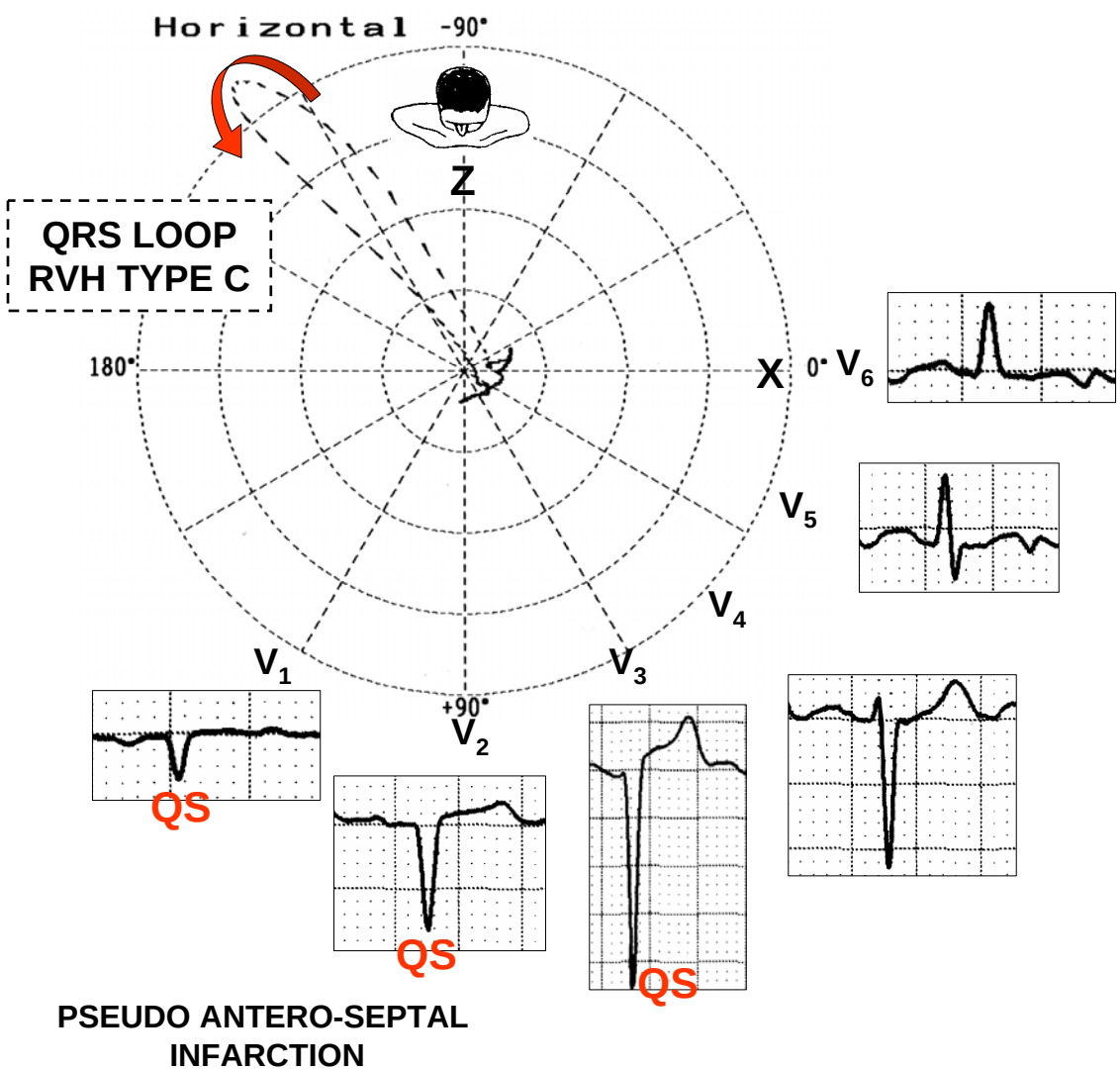
RVE TYPE C, III or SPECIAL

RVE – Vectorcardiographic type C: QRS loop of clockwise rotation and of location predominant in the right posterior quadrant. QS or rS from V_1 to V_6.



ECG/VCG correlation in the HP in RVH vectorcardiographic type C, III or special.

ECG/VCG HORIZONTAL PLANE



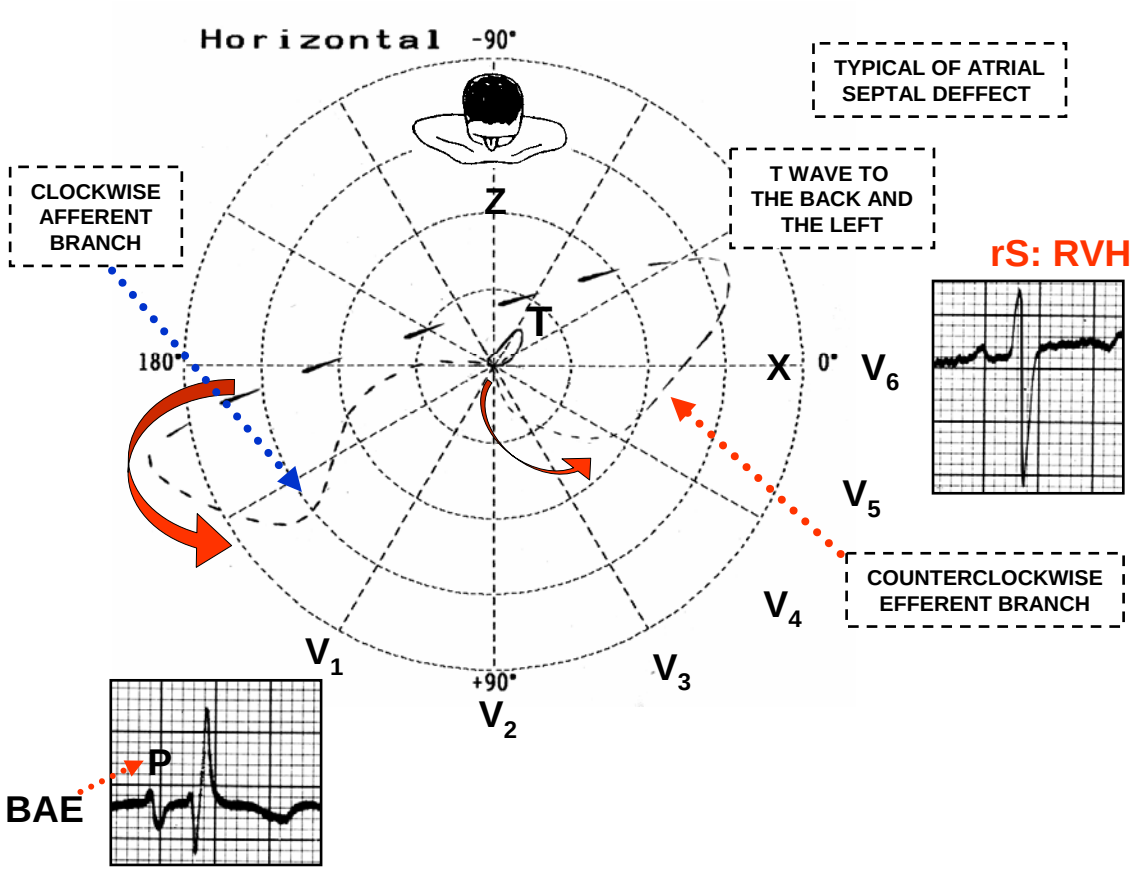
Predominant vectorcardiographic pattern of QRS loop of RVE type C characterized by presenting in the HP: counterclockwise rotation or rotation in eight, posterior shift: more than 70% of the area of the loop in posterior quadrants and more than 20% of in the right posterior one.
In this extreme case, 100% of the QRS loop is in the right posterior quadrant.

QS from V_1 to V_3 pattern of pseudo anteroseptal infarction, by the relatively high position of the precordial electrodes in relation to the height of the heart as a consequence of diaphragm descent pushed by hyperinsufflated lungs.
Tendency to low voltage in left precordial leads.

ECG/VCG correlation in the HP of RVH type C by emphysema.

TYPE D RVH or IV

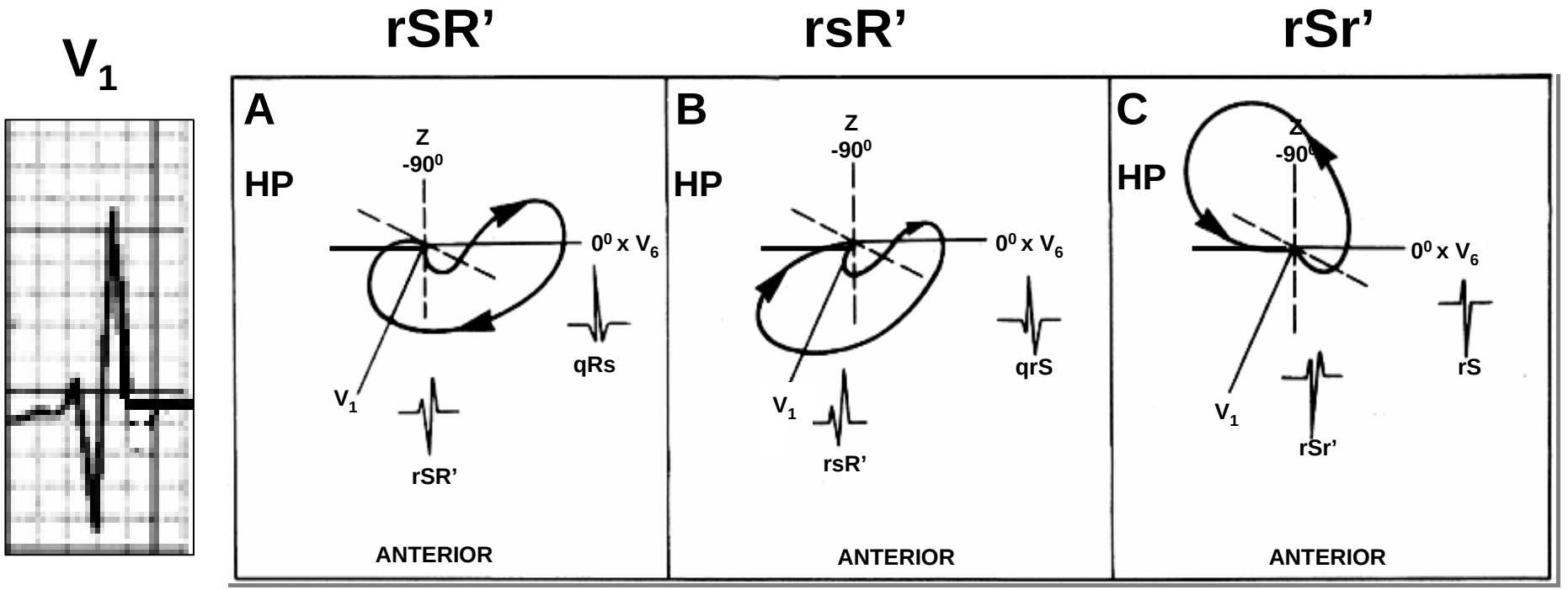
VOLUME OR DIASTOLIC HYPETROPHY OF THE RIGHT VENTRICLE



ECG/VCG correlation in the HP in RVE vectorcardiographic type D or IV. Triphasic pattern in righ precordial leads, similar to RBBB.

TYPE D or IV RVH:

DIASTOLIC, VOLUME OR ECCENTRIC RVH



The hypertrophied portion of the right ventricle is predominantly the crista or right ventricular outflow tract. It is typically found in atrial septal defects ASD (93%), moderate pulmonary stenosis (PS) and mitral stenosis (MS) with pulmonary hypertension.

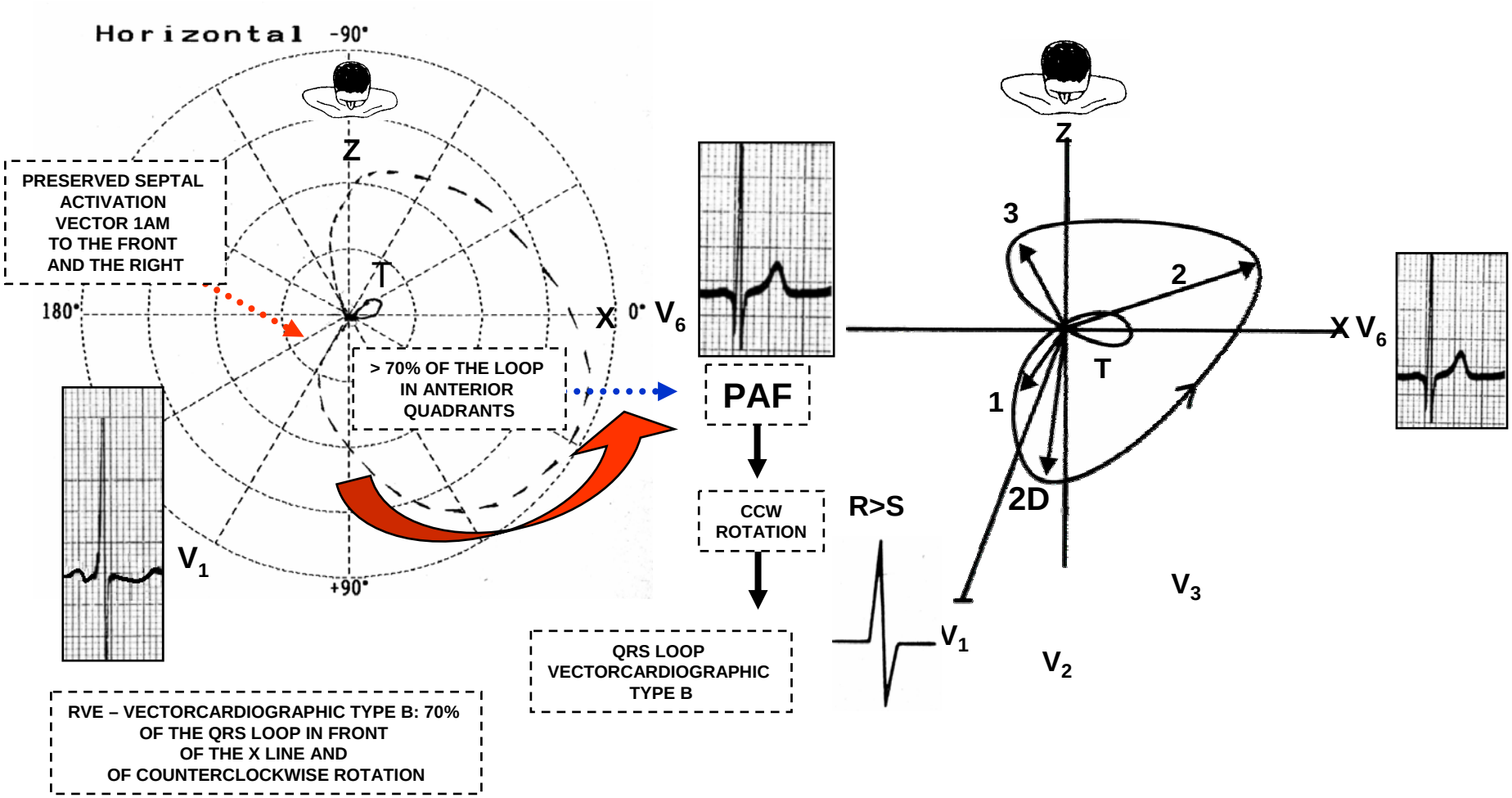
ECG/VCG correlation in the HP in RVH vectorcardiographic type D or IV.

RVH RELATED TO SEVERITY

- **Mild or initial RVH/RVE**
- **Moderate RVH/RVE**
- **Severe RVH/RVE**
- **Extreme RVH/RVE**

Types of RVH by severity: mild, moderate, severe and extreme.

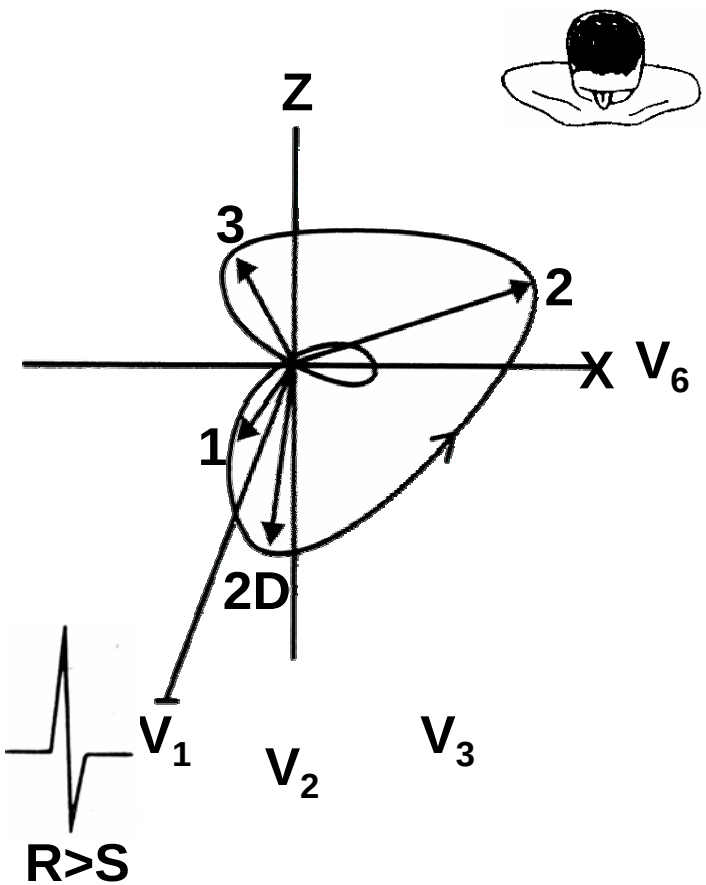
MILD OR INITIAL RVH

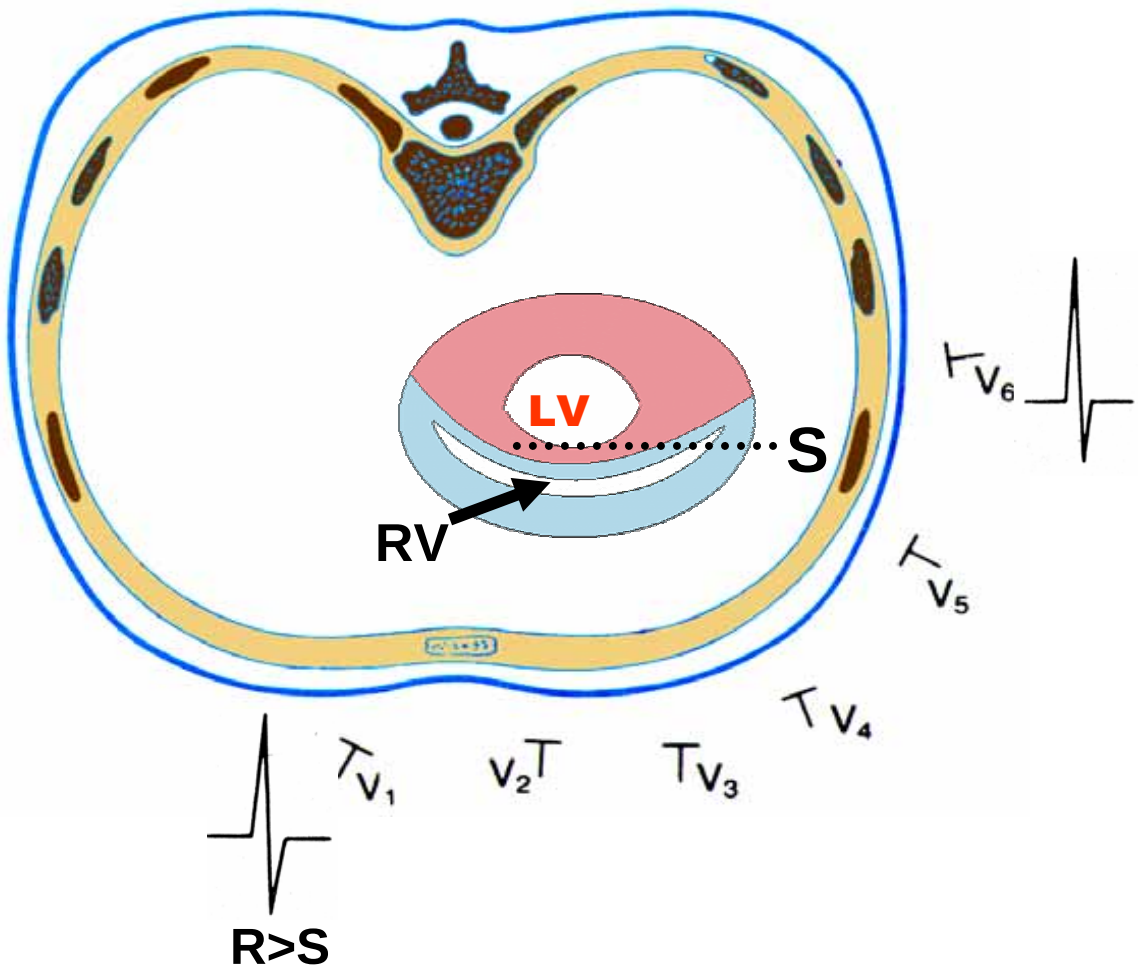


R of V_1 and V_2, > 7 mm in V_1 in adults

ECG/VCG correlation in the HP in mild RVH.

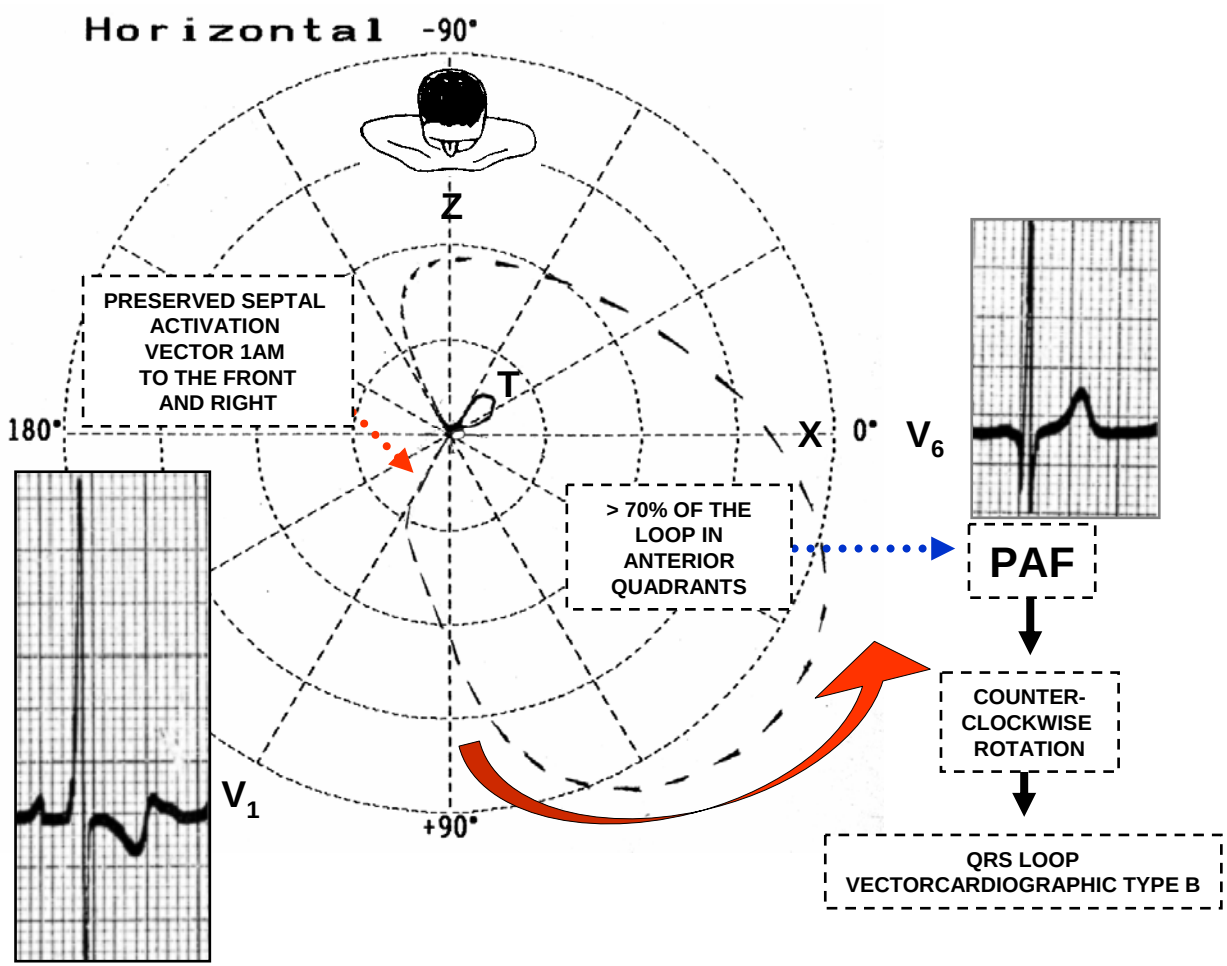
SPATIAL NOTION OF VENTRICLES IN RVH (MILD OR MODERATE) IN THE HORIZONTAL PLANE





Representation in the HP of ventricular activation in mild and moderate RVH/RVE.

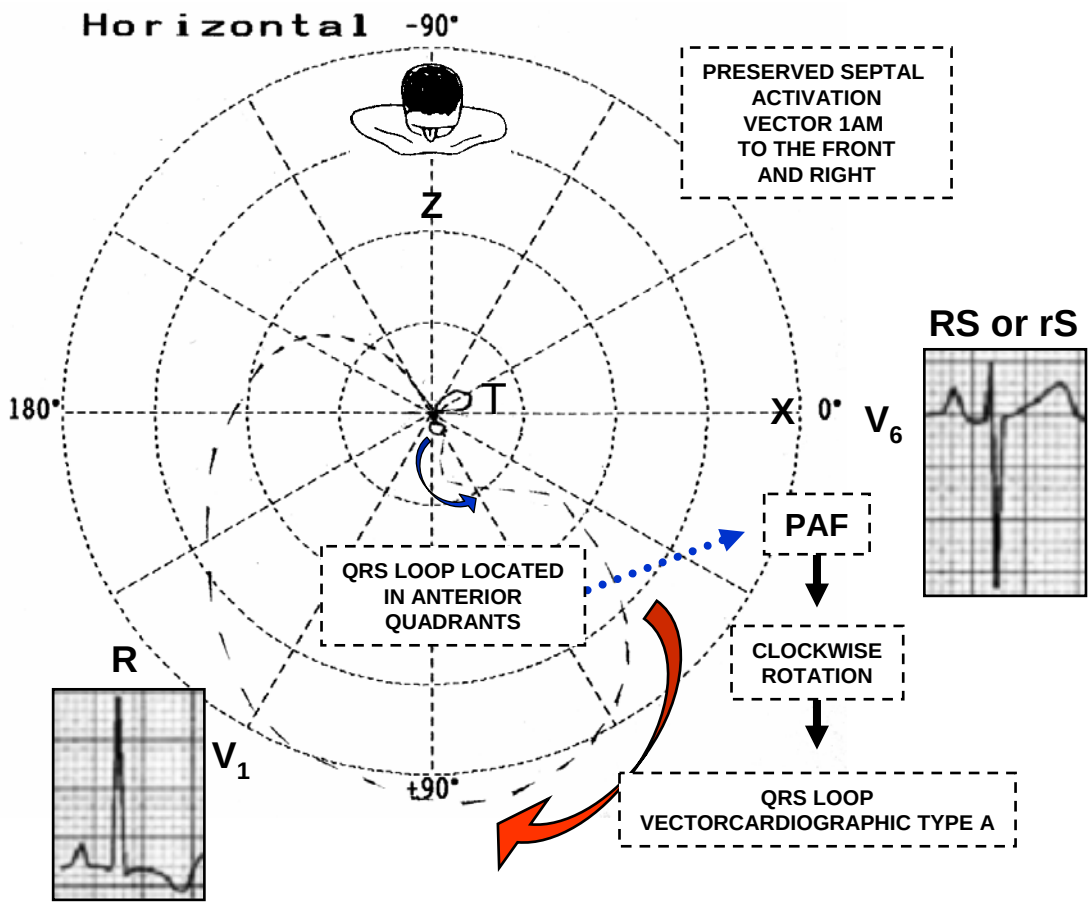
MODERATE RVH



RVH – VECTORCARDIOGRAPHIC TYPE B: 70% of QRS loop in front of the X line of counterclockwise rotation.

ECG/VCG correlation in the HP in moderate RVH.

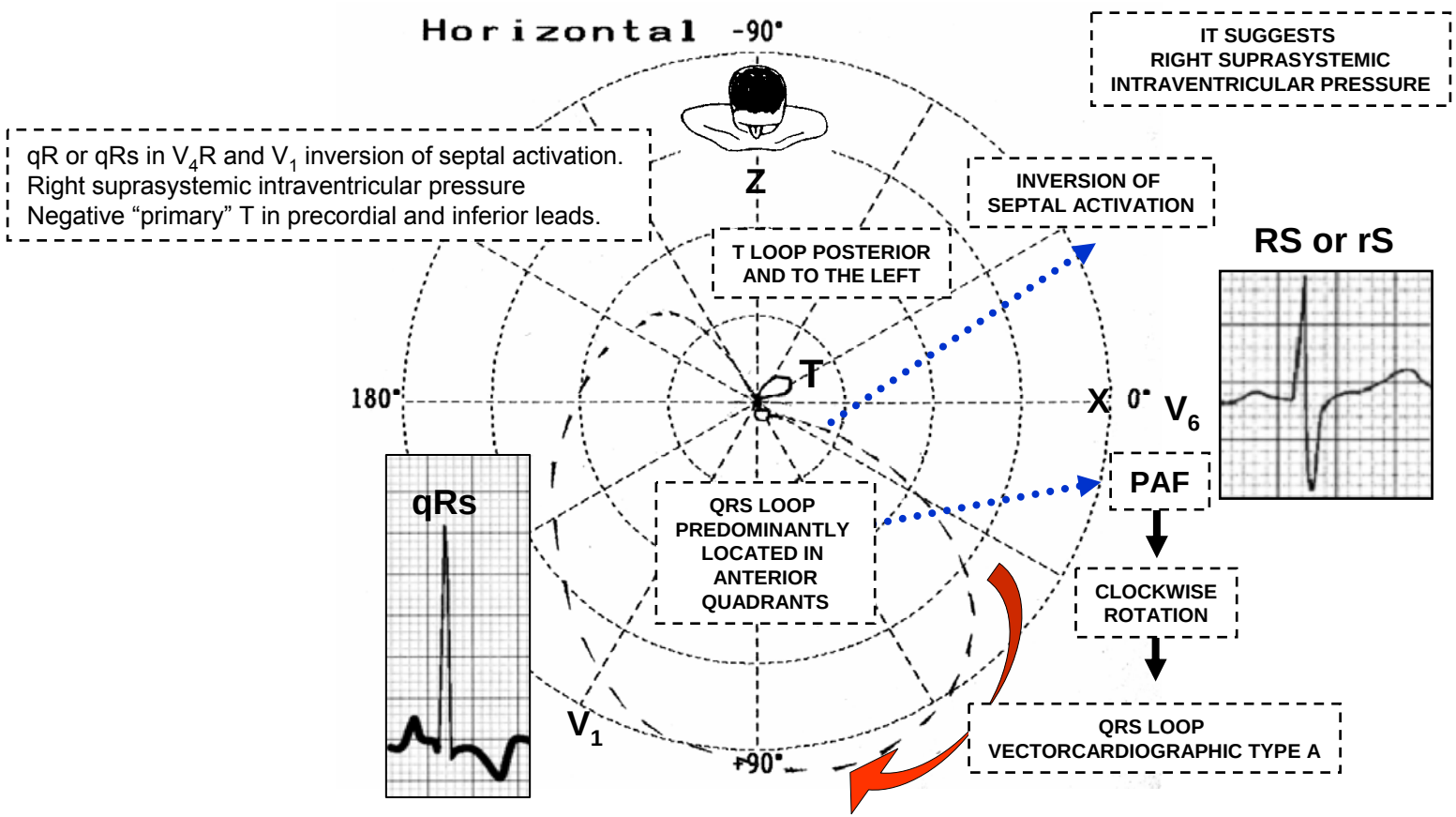
SEVERE RVH



Systolic pattern, pure R from V_1 to V_4 with negative T and marked clockwise rotation.

ECG/VCG correlation in the HP in moderate RVH.

EXTREME RVH



ECG/VCG correlation in the HP in extreme RVH.

PROMINENT ANTERIOR FORCES

We consider there is presence of PAF in ECG, when the voltage of R wave in any precordial lead of the anterior or anteroseptal wall from V1 (+115º) through V4 (+47º) is greater than the normal maximal limit for gender and age. Electro-vectocardiographic criteria of PAF should be age-related and gender-related.

Thus, in lead V1 in adults between 20 and 30 years old, R wave > 8.9 mm in women and in men > 5.3 mm is considered a criterion for PAF.

From 30 to 40 years old, in women R wave voltage > 5.4 mm and in men > 5.8 mm is considered a criterion for PAF.

Finally, from 40 to 60 years old, R wave > 4.9 mm in women, and > 4.0 mm in men is considered a criterion for PAF. Another criterion used by some authors to consider the presence of PAF regards the R/S ratio in V1. Thus, an R/S ratio in V1 ≥1 is considered abnormal in adults. Tall R V1 is defined as an R/S ratio ≥ 1. From our point of view, this criterion with these values cannot be considered as valid, since in 1% of normal individuals this ratio (R/S ratio in V1 ≥1) is found as a normal variant.

In lead V2, approximately in 25% of men and 12% of women the R/S ratio is 1.

1. Lepeschkin E: In: Altman PE. Dittmer DS (eds) Respiration and Circulation. Bethesda, Federation of American Societies for Experimental Biology, 1971; p 227.
2. Macfarlane PW, Lawrie TDV, eds. The normal electrocardiogram and vectorcardiogram. In: Comprehensive Electrocardiology: Theory and Practice in Health and Disease. Vol 1-3. New York, NY: Pergamon Press, 1989.

The normal amplitudes of R waves in lead V2 are:

From 20 to 30 years old, R wave > 13.9 mm in women and > 9.2 mm in men is considered a criterion for PAF.

From 30 to 40 years old, R wave > 12.1 mm in women and > 10.1 mm in men is considered a criterion for PAF.

From 40 to 60 years old, R wave > 12.0 mm in women and > 9.1 mm in men is considered a criterion for PAF.

The normal amplitudes of R waves in lead V3 are:

From 20 to 30 years old, R wave > 11.6 mm in women and > 8.2 mm in men is considered a criterion for PAF.

From 30 to 40 years old, R wave > 9.4 mm in women and > 7.1 mm in men is considered a criterion for PAF.

From 40 to 60 years old, R wave > 8.4 mm in women and > 7.1 mm in men is considered a criterion for PAF.

The normal amplitudes of R waves in lead V4 are:

From 20 to 30 years old, R wave > 27.7 mm in women and > 19.6 mm in men is considered a criterion for PAF.

From 30 to 40 years old, R wave > 29.2 mm in women and > 25.9 mm in men is considered a criterion for PAF.

From 40 to 60 years old, R wave > 25.6 mm in women and > 23.6 mm in men is considered a criterion for PAF.

PROMINENT ANTERIOR FORCES DEFINITION BY VECTOCARDIOGRAPHIC PARAMETERS

We consider vectocardiographically that there is PAF when the vector of the 42 ms moment of the QRS loop of the HP, is located in the anterior quadrants, or when ≥50% of the area of the QRS loop is in the anterior quadrants (to the front of the orthogonal X lead) (0º to ±180º). See figure 28.
The maximal spatial QRS vector magnitude, as well as the maximal QRS and T vector magnitudes in the FP, HP, and right sagital plane (RSP), are observed to decrease significantly with advancing age in both sexes and are significantly larger in men in all age groups. There are significant age- and sex-dependent differences in normal VCG parameters. These are of potential significance for diagnostic applications. (*1; 2*).

1. **Yang TF, Macfarlane PW. Normal limits of the derived vectorcardiogram in Caucasians. Clin Physiol. 1994; 14: 633-646.**
2. **Yang TF, Chen CY, Chiang BN, Macfarlane PW. Normal limits of derived vectorcardiogram in Chinese. Electrocardiol. 1993; 26: 97-106.**

POSSIBLE CAUSES FOR PROMINENT ANTERIOR FORCES

In the presence of PAF in the anterior wall (tall R waves) in right and/or middle precordial leads V1 through V3 or V4, the following differential diagnosis should be excluded clinico-electro-vectocardiographically (*1*)
(*modified from Zema*):

1. Normal subjects: PAF are observed in only 1% of normal subjects. (*2*) We distinguish two main types: Normal variant with CCW rotation of the heart around the longitudinal axis; and the Athlete's heart.

2. Misplaced precordial leads. (*3*)

3. Strictly posterior, posterobasal, high posterobasal, posterior or dorsal, posterolateral, posteroinferior, and postero-lateral-inferior MI;

4. Right ventricular hypertrophy (RVH): vectocardiographic types A and B;

5. Diastolic LVH, volumetric or eccentric LVH, secondary to septal hypertrophy (magnitude of increase of vector 1AM) and CCW heart rotation around the longitudinal axis;

1. Zema, MJ: Electrocardiographic tall R waves in the precordial leads. J Electrocardiol 1990; 23:147-156.
2. Mattu A, Brady WJ, Perron AD, et al. Prominent R wave in lead V1: electrocardiographic differential diagnosis. Am J Emerg Med. 2001; 19: 504-513.
3. (MacKenzie R. Tall R wave in lead V1. J Insur Med. 2004; 36:255-259.

6. CRBBB, Kennedy type III, vectocardiographic type c, Kennedy type II, or Grishman type and Kennedy type I, or Cabrera type;

7. Pre-excitation variant of Wolff-Parkinson-White syndrome, with accessory anomalous pathways (Kent fibers), located in a posterior location (Type A): right posterior, right and left posterior paraseptal and left posterior paraseptal and left posterior pre-excitation;

8. HCM: O-HCM and NO-HCM forms;

9. Progressive muscular dystrophy, progressive muscular dystrophy of childhood, Duchenne's cardiomyopathy, Duchenne's muscular dystrophy, X-linked muscular dystrophy, pseudo-hypertrophic muscular dystrophy, childhood muscular dystrophy;

10. Endomyocardial fibrosis;

11. Dextroposition. Example: left pneumonectomy.

12. Left Septal Fascicular Block;

13. A combination of the above.