Demonstration of greater sensitivity of VCG related to ECG for the diagnosis of lateral myocardial infarction in the chronic phase in presence of LBBB

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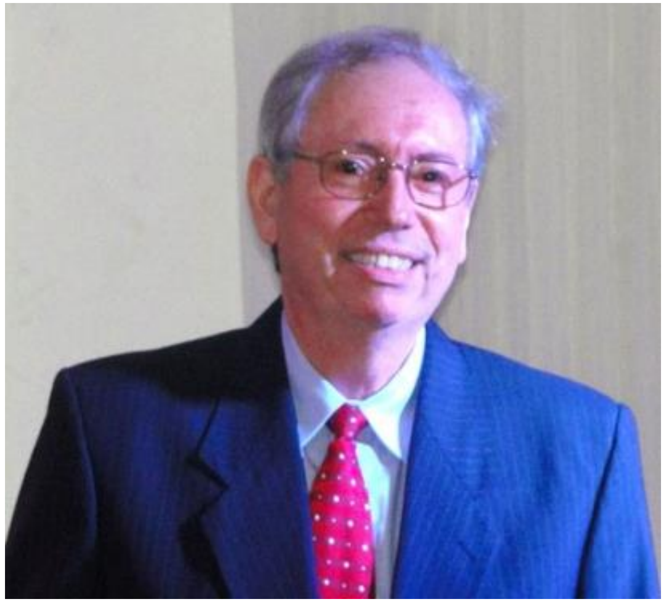

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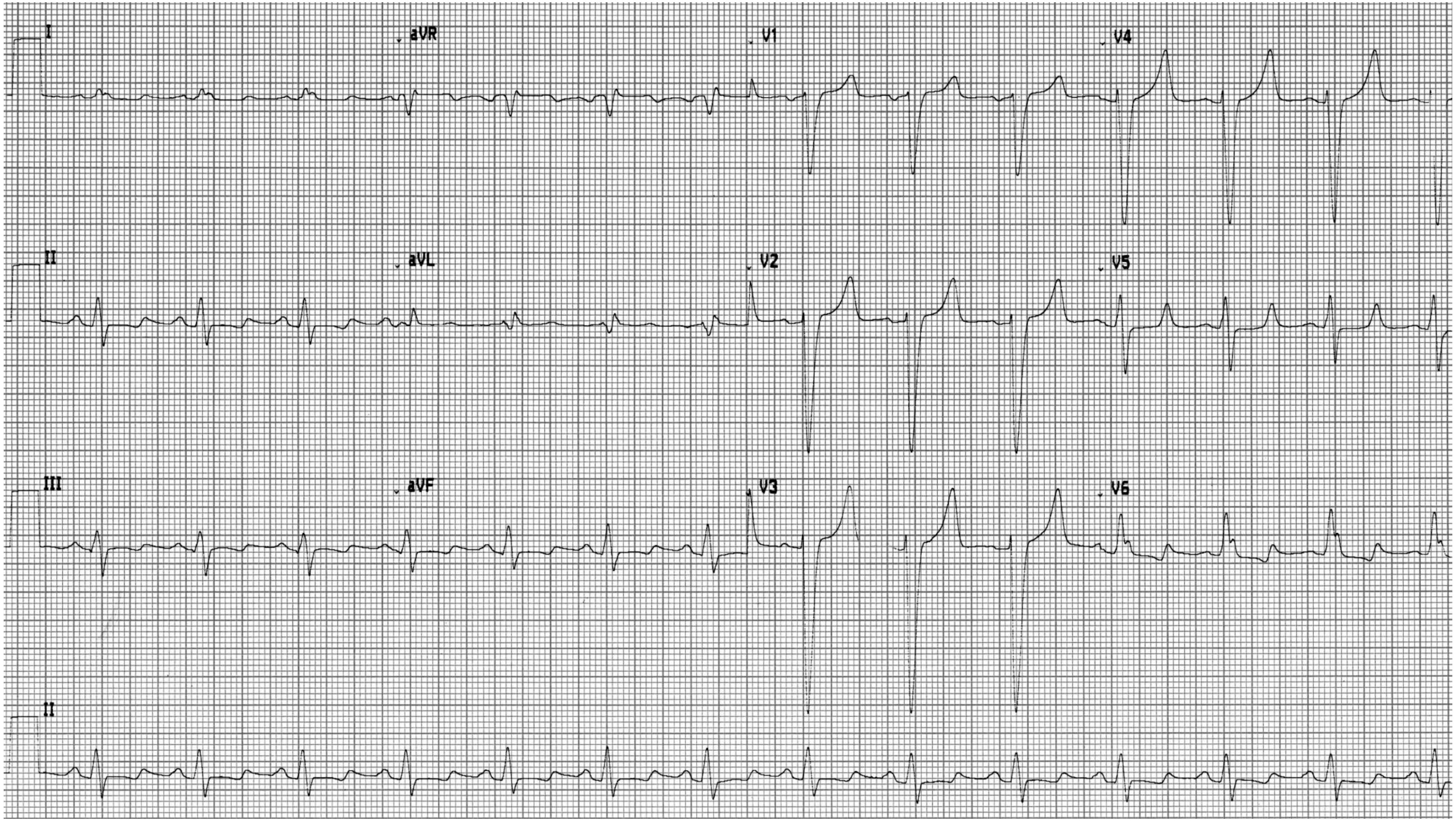
Alberto Studart Gomes. Fortaleza – CE- Brazil

Name: ZAPO; **Age:** 48 y/o; **Weight:** 63 kg; **Height:** 1.57 m; **Ethnic group:** Caucasian; **Medication in use:** levothyroxine sodium 100 mcg, spironolactone 25 mg, furosemide 40 mg, losartan potassium 50mg 2x/day, metformin 850 mg 3x/day, acetylsalicylic acid 100 mg/day.

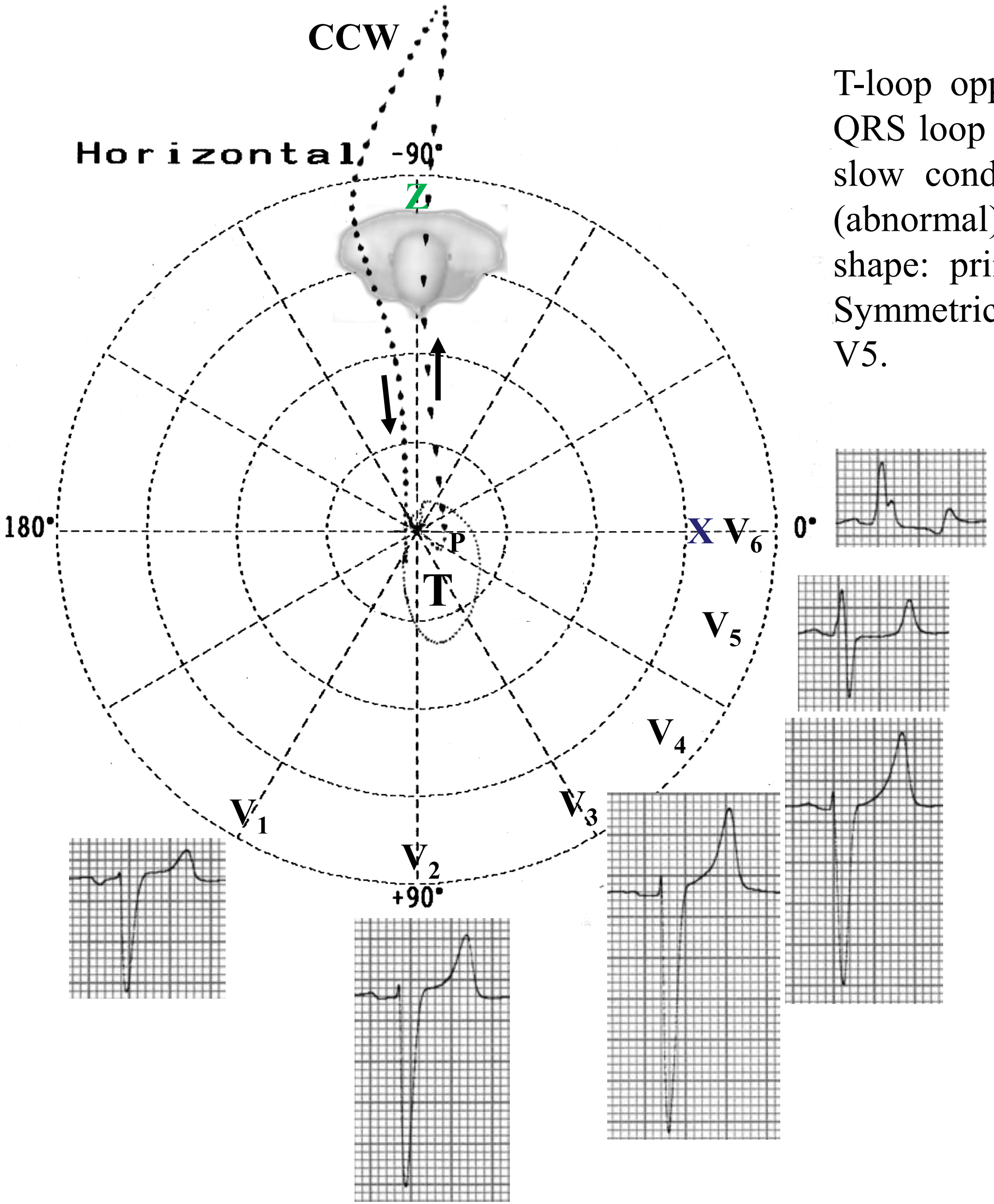


Clinical diagnosis: Diabetes mellitus type 2, moderate renal insufficiency, glaucoma, congestive heart failure (anasarca), hypothyroidism, tobacco dependency.

ECG diagnosis: LBBB

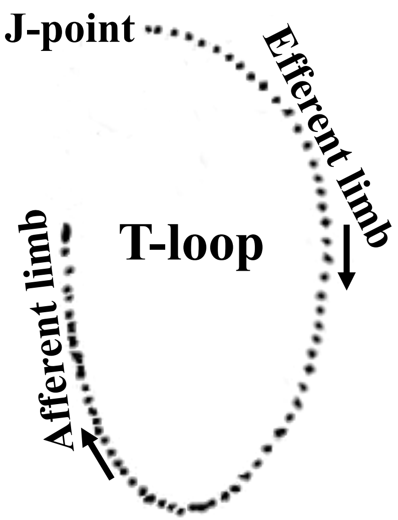
ECG/VCG correlation in the Horizontal Plane

QRS loop shape is elongated and narrow, the efferent limb located to left related afferent limb and has CCW rotation (inversion related to uncomplicated LBBB), afferent limb on right posterior quadrant. ≈60% of QRS area is located in right posterior quadrant. **Conclusion:** LBBB complicated with lateral MI.

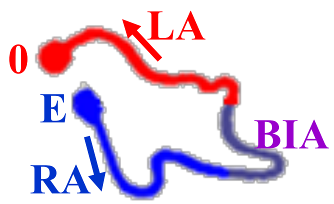


T-loop opposite related QRS loop with uniform slow conduction speed (abnormal) and rounded shape: primary T-loop. Symmetrical T-wave in V5.

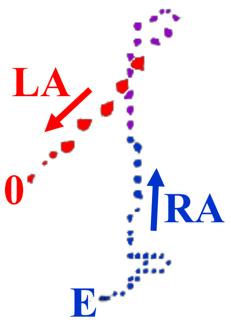
Magnified T-loop



Normal P-loop rotation



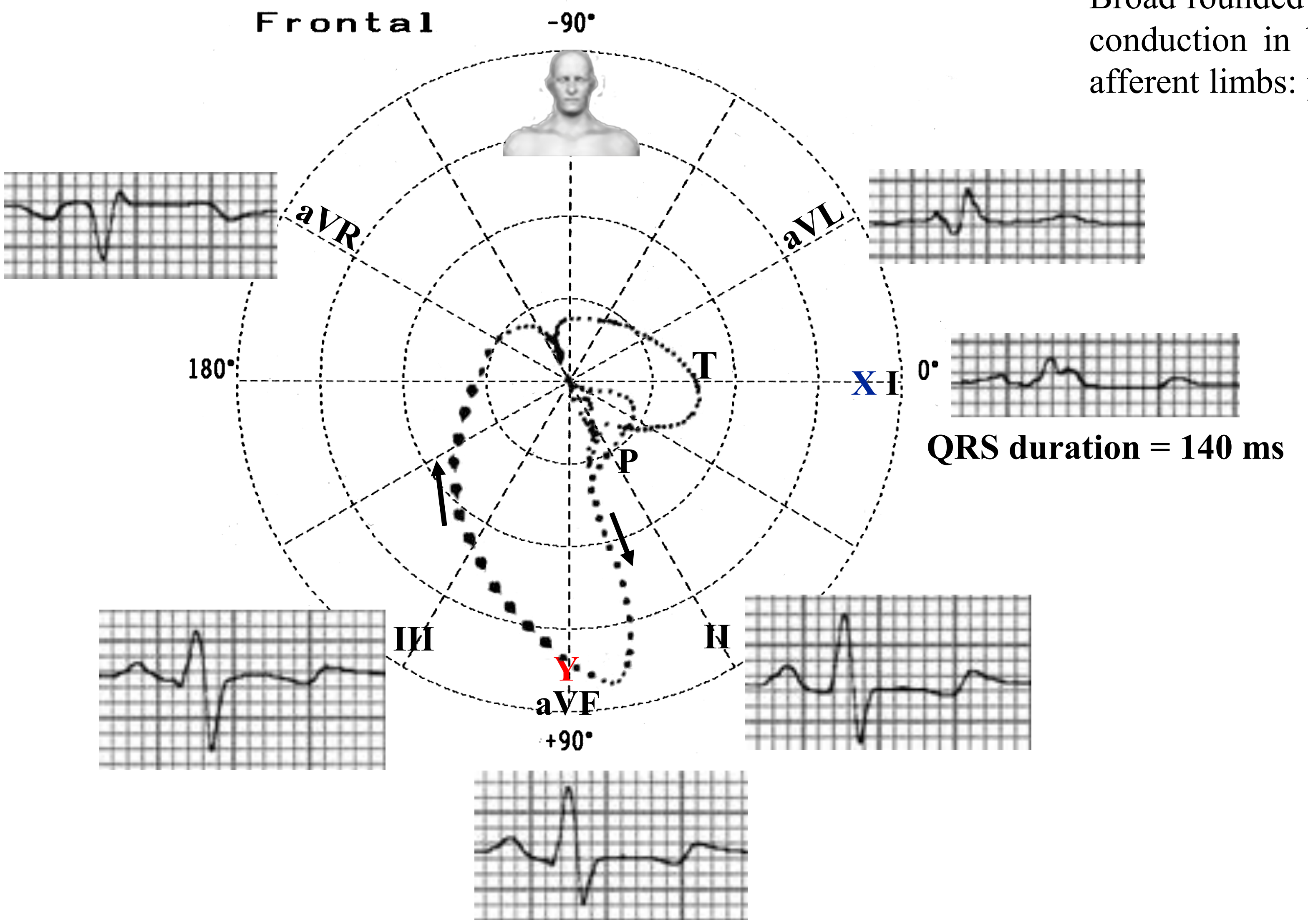
Magnified P-loop



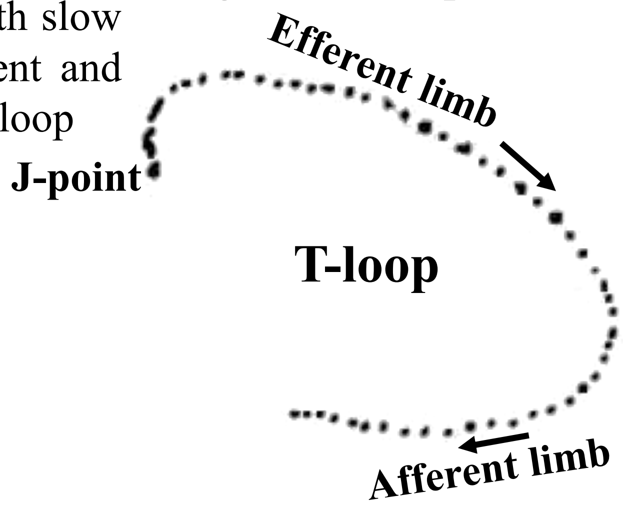
P-loop

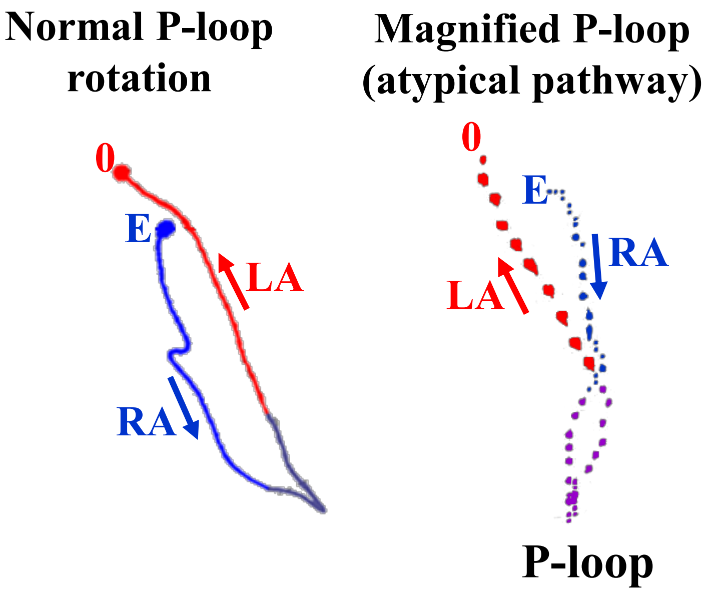
P-loop with figure in 8 (normal), augmented posterior forces (>0.04 mV): LAE

ECG/VCG correlation in the Frontal Plane



Broad rounded T-loop with slow conduction in both efferent and afferent limbs: primary T-loop

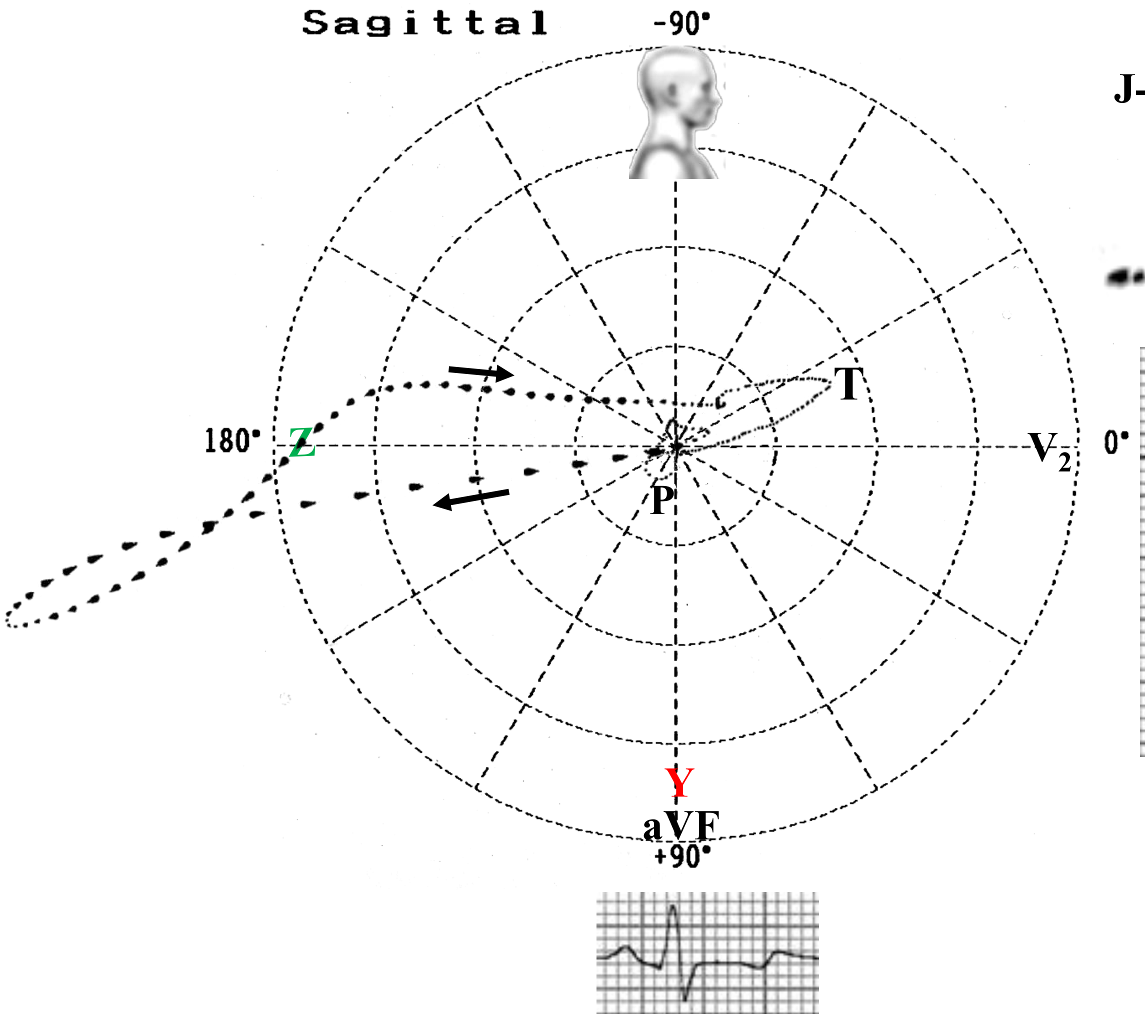


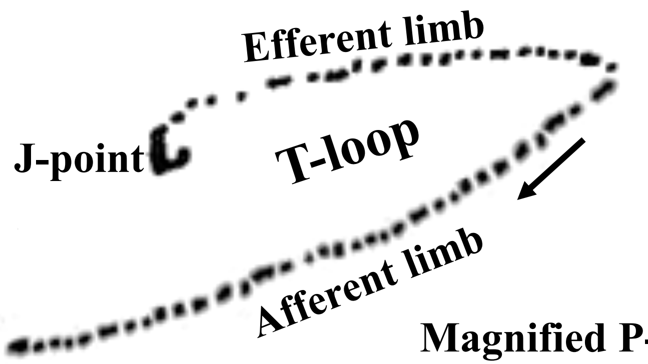


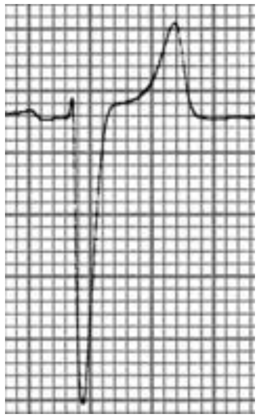
Magnitude of the QRS loop is small because it has predominant anteroposterior direction (near perpendicular to orthogonal X lead). See in RSP.

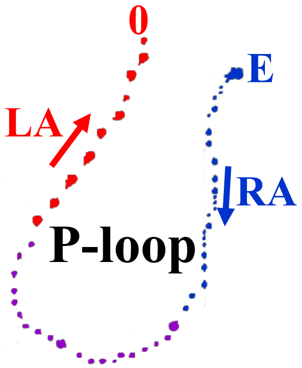
ECG/VCG correlation in the Right Sagittal Plane

QRS loop rotation in eight almost perpendicular to the FP, the vector of the initial 20ms directed forward, morphology fulfilled and narrowed with efferent branch of faster inscription directed from front to back and lower and the afferent branch of inscription slower directed from back to front and above, maximum vector increased in magnitude and located at +170°, vector ST/T opposite the vector of the QRS loop forming between them an angle of 180°. T-loop directed forward and above with clockwise rotation. Both afferent and efferent limbs showing slow conduction: ischemic symmetric T-loop.

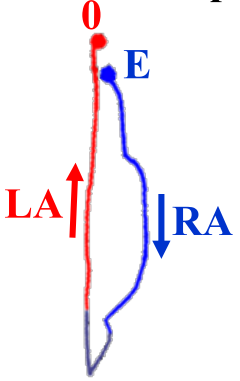




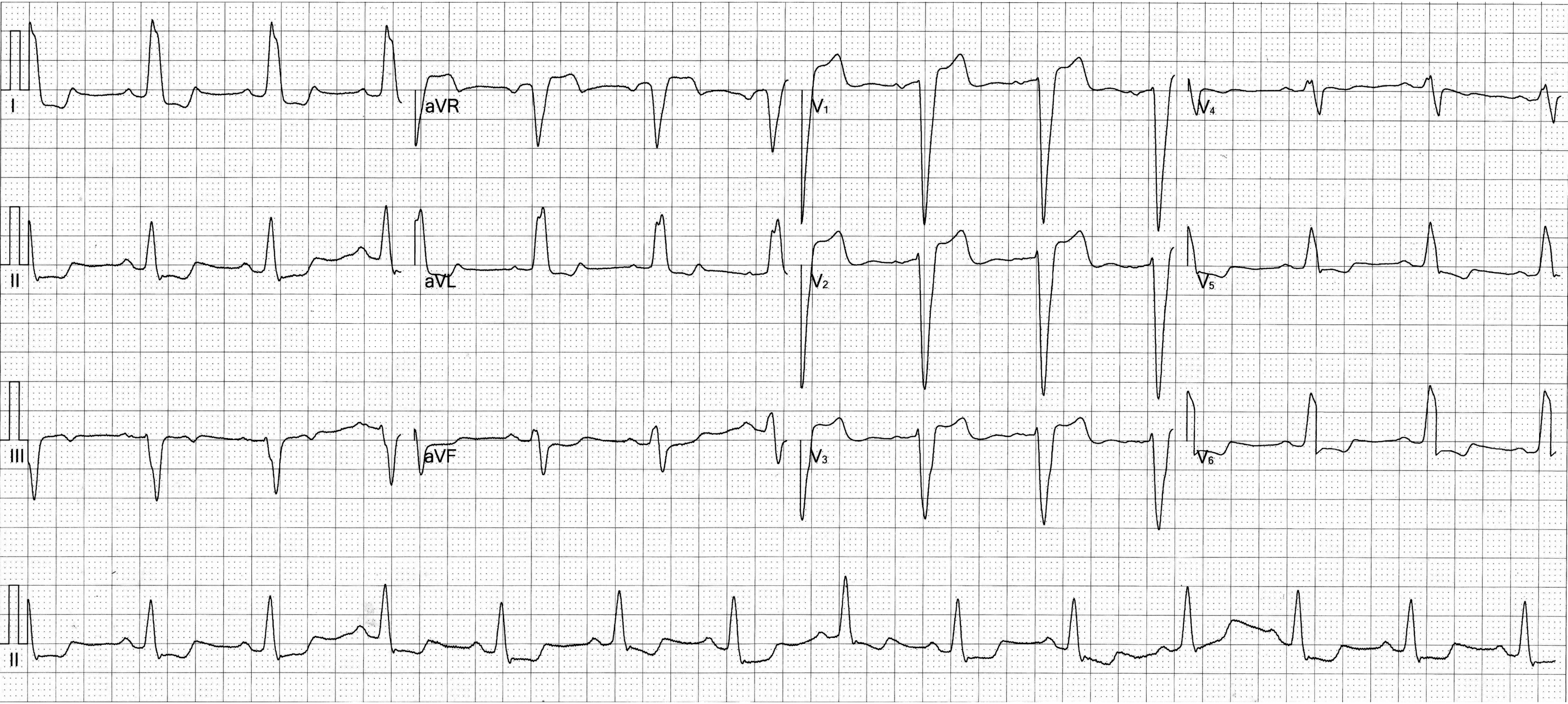




P-loop with LA portion dislocated to back: LAE.



Name: ABC; **Sex:** F; **Ethnic group:** Caucasian; **Age:** 61 y/o; **Weight:** 58 kg; **Height:** 1.51 m; Drugs: metformin 850 mg 2x/day, gliclazide 30 mg 1x/day, rosuvastatin 5 mg; spironolactone 25 mg 1x/day, carvedilol 12,5 mg 2x/day, furosemide 40 mg 1x/day

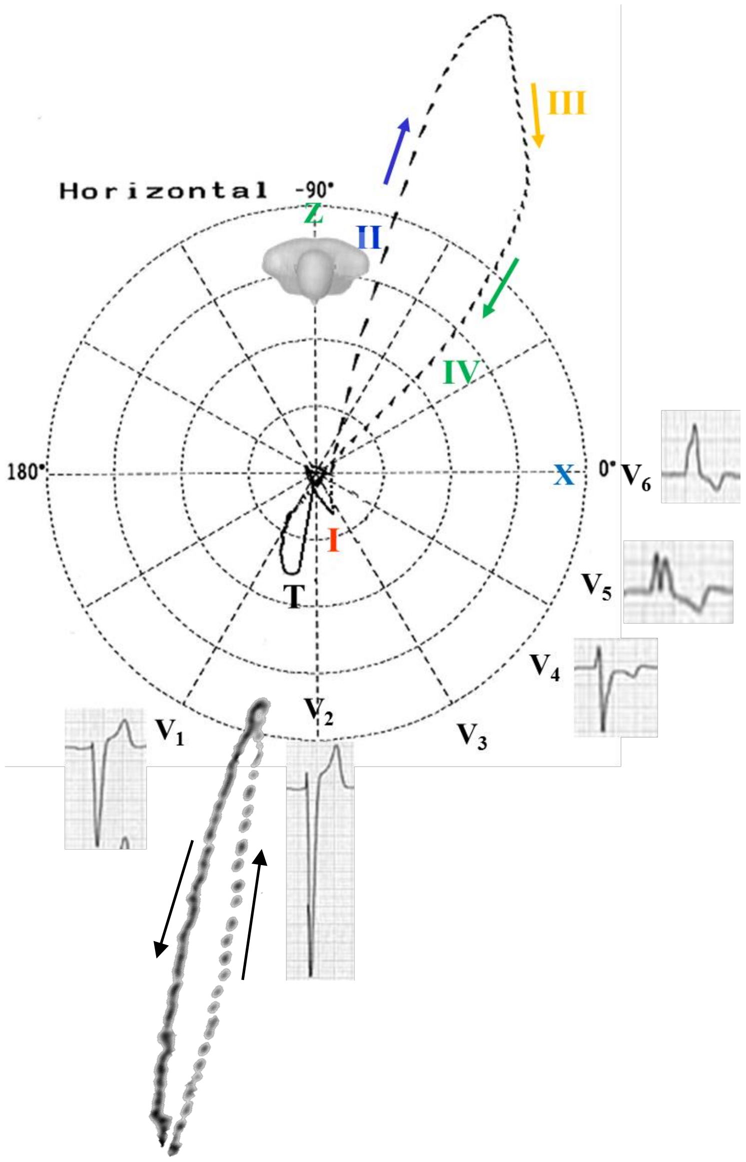


Clinical diagnosis: dilated cardiomyopathy, dyslipidemia, type 2 diabetes mellitus, complaints functional class II NYHA, LVEF 45, negative cardiac stress scintigraphy.

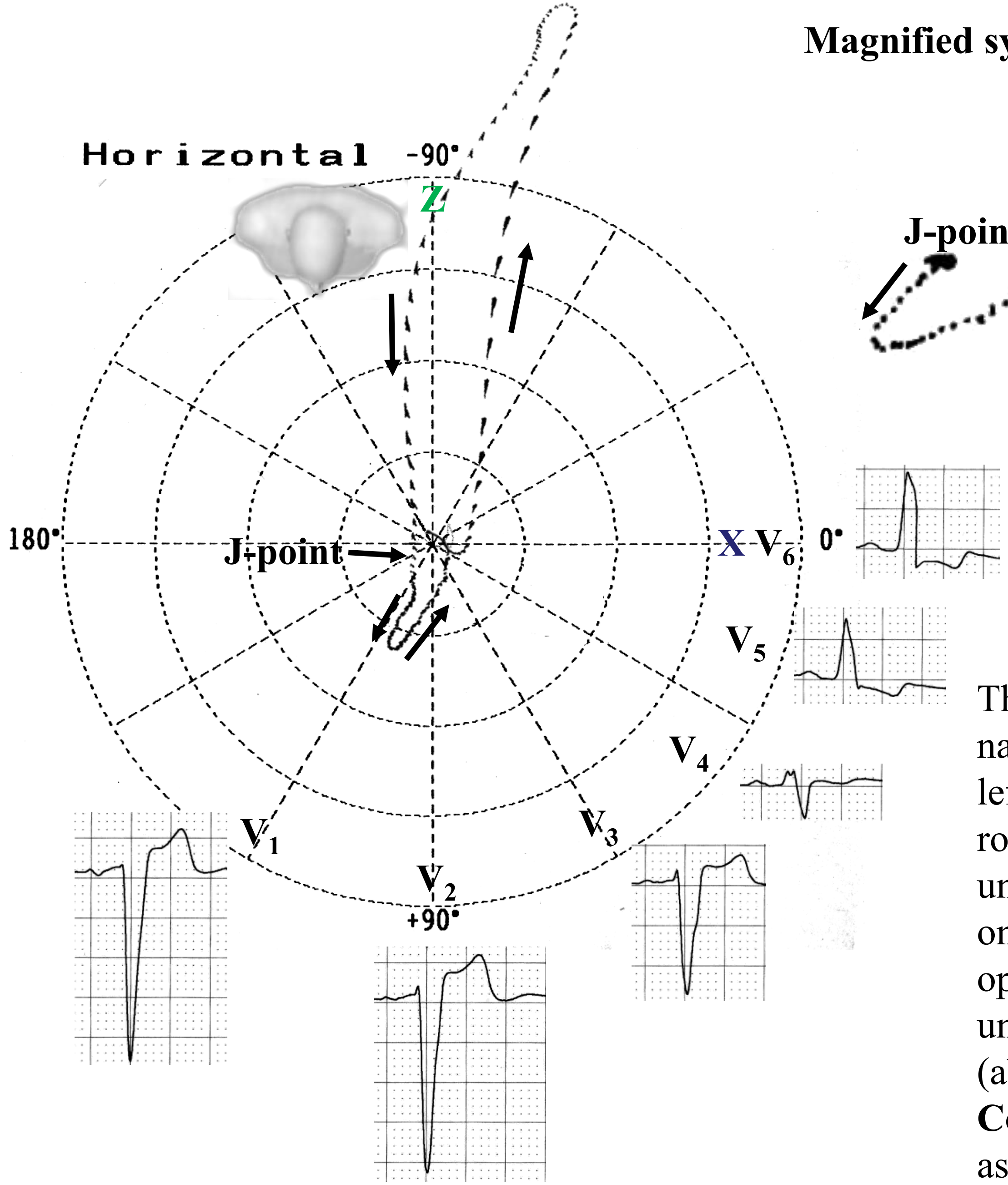
ECG diagnosis: LBBB.

ECG/VCG correlation in the Horizontal Plane

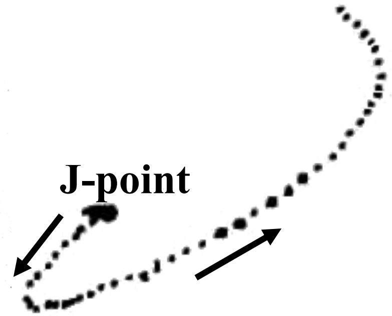
Uncomplicated LBBB



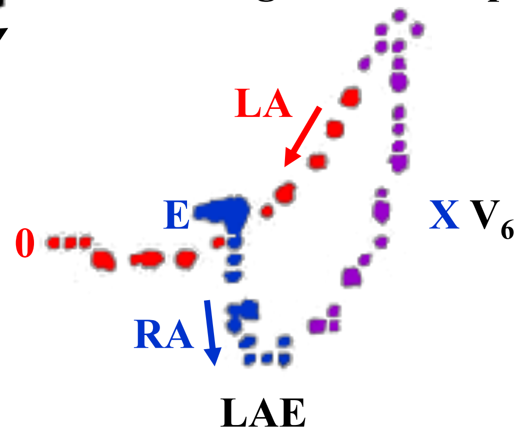
(Polu 1972)



Magnified symmetric T-loop



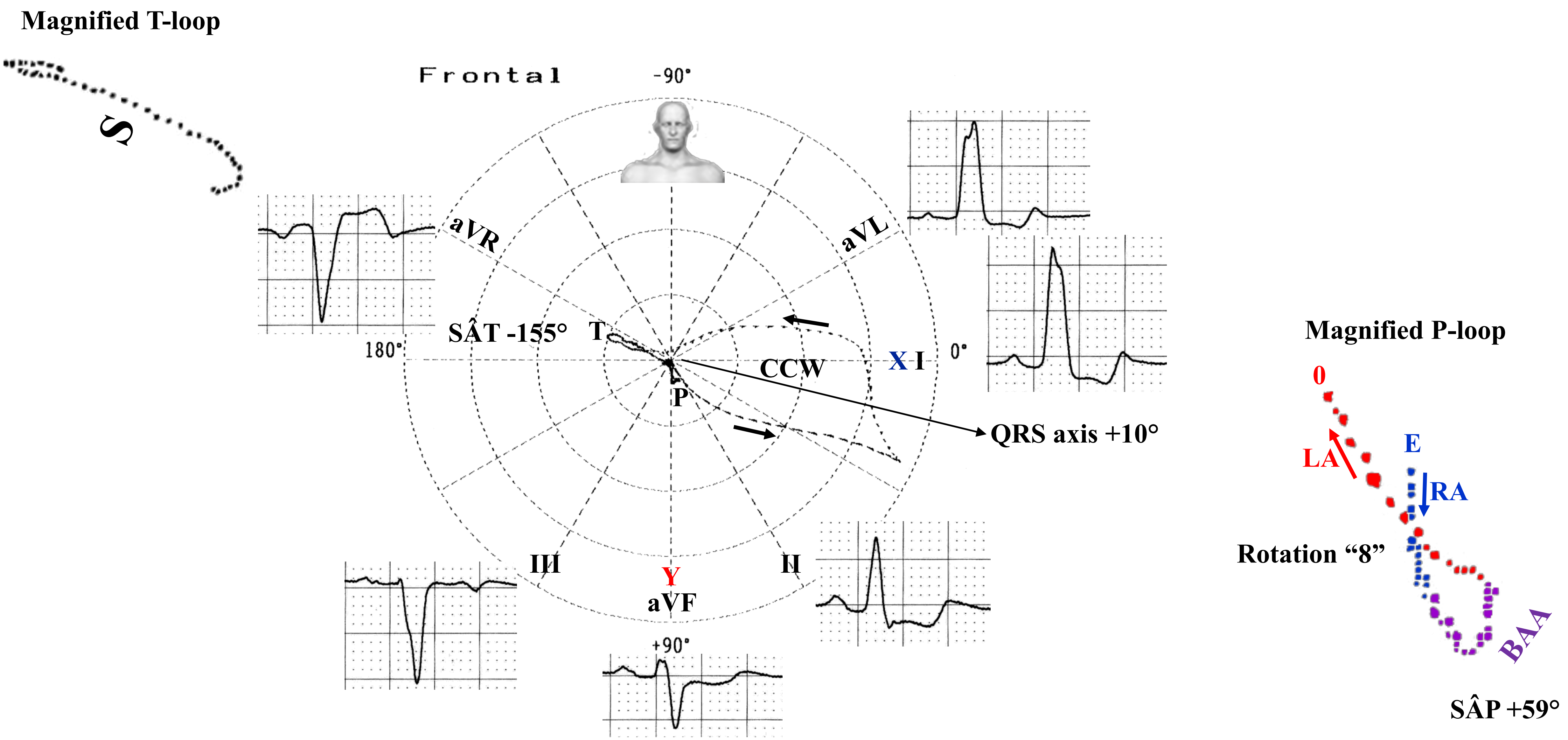
Magnified P-loop



The QRS loop shape is elongated and narrow, the efferent limb located to left related afferent limb and CCW rotation (inversion related to uncomplicated LBBB), afferent limb on right posterior quadrant, T-loop opposite related QRS loop with uniform conduction speed (abnormal).

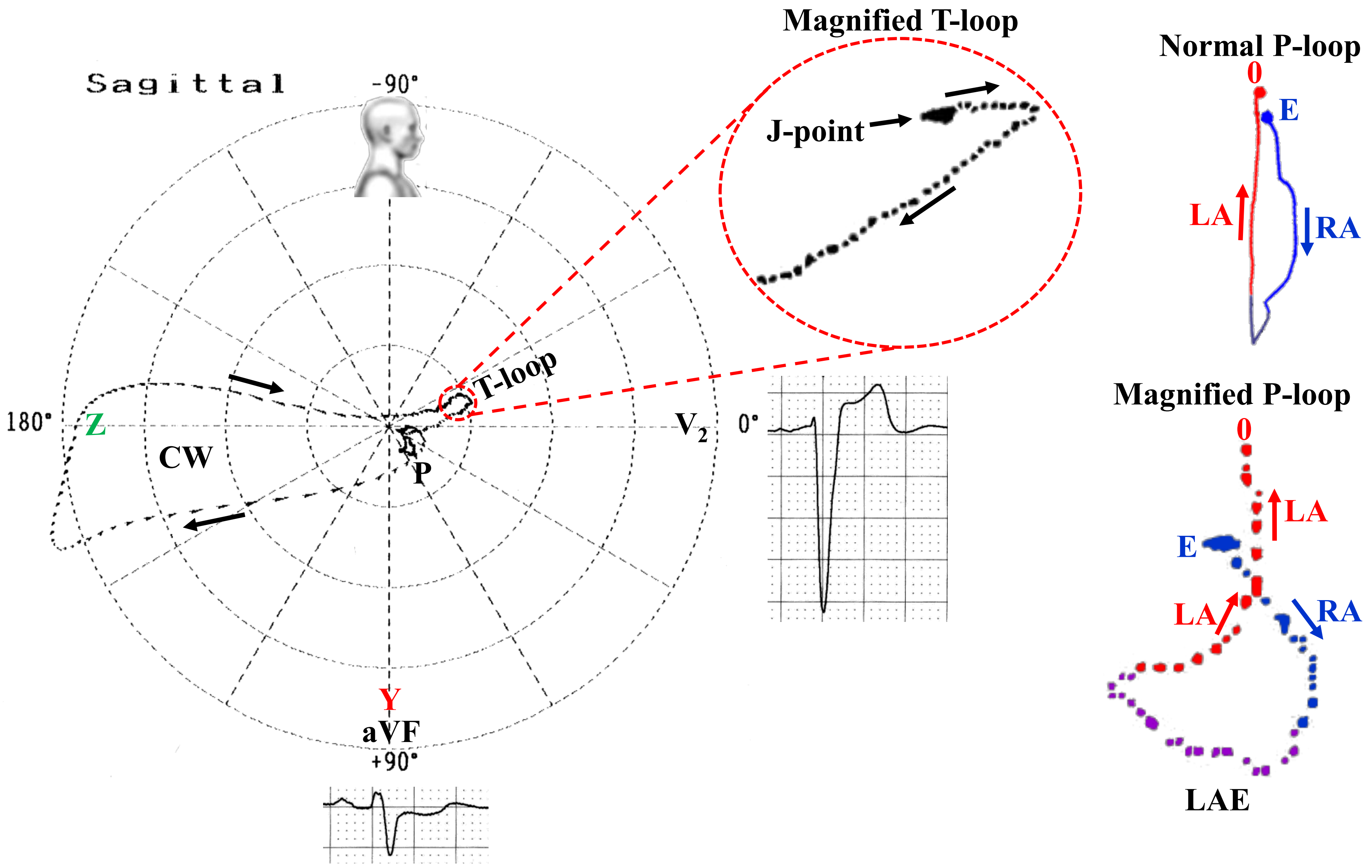
Conclusion: LAE + LBBB associated with lateral MI

ECG/VCG correlation in the Frontal Plane



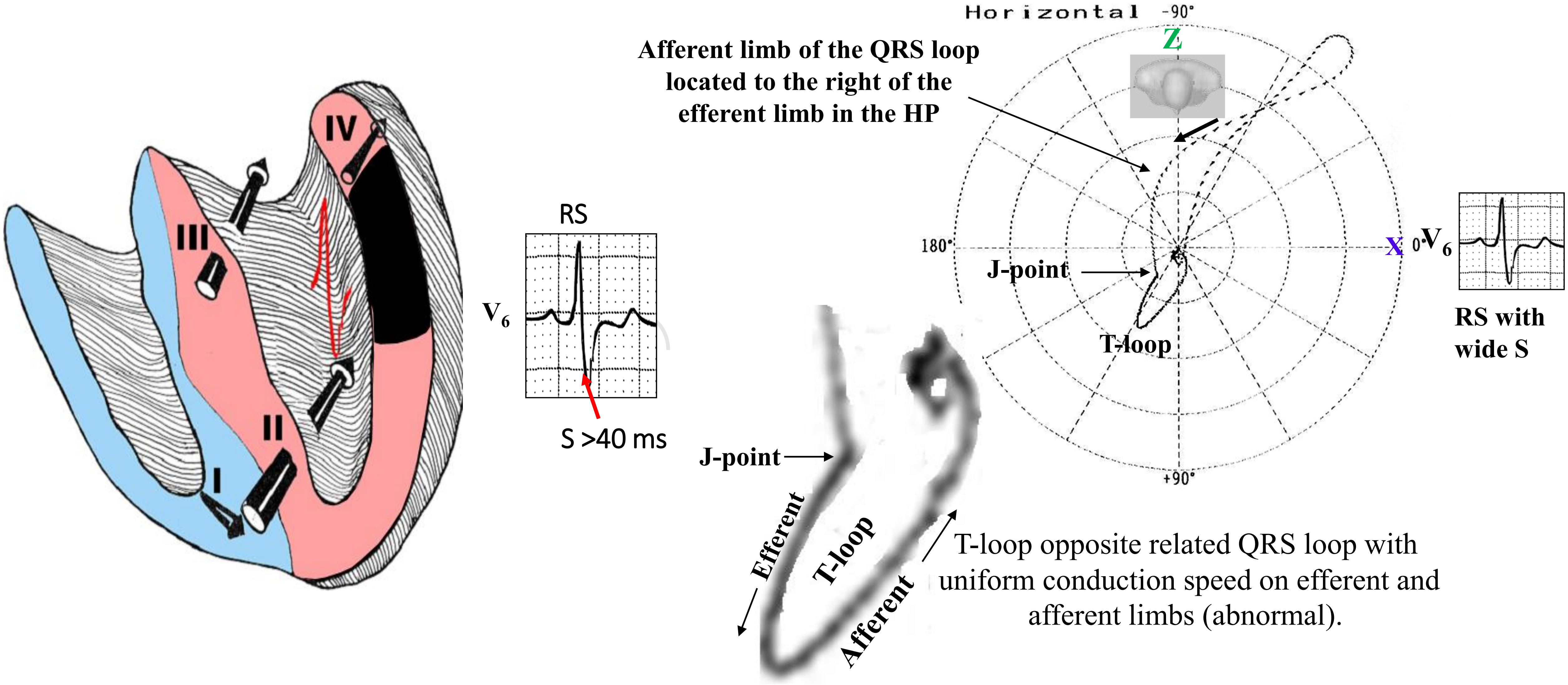
CCW: counterclockwise rotation; **QRS axis +10°; SÂT -155°;** QRS loop with characteristic middle final delay; direction of maximal vector +20° (in LBBB it is usually between +30° and –30°); vectors of ST and T opposite to QRS (angle around 180°) and T-loop with S shape. In isolated LBBB T-loop has counterclockwise rotation. BAA: Biatrial Activation

ECG/VCG correlation in the Right Sagittal Plane



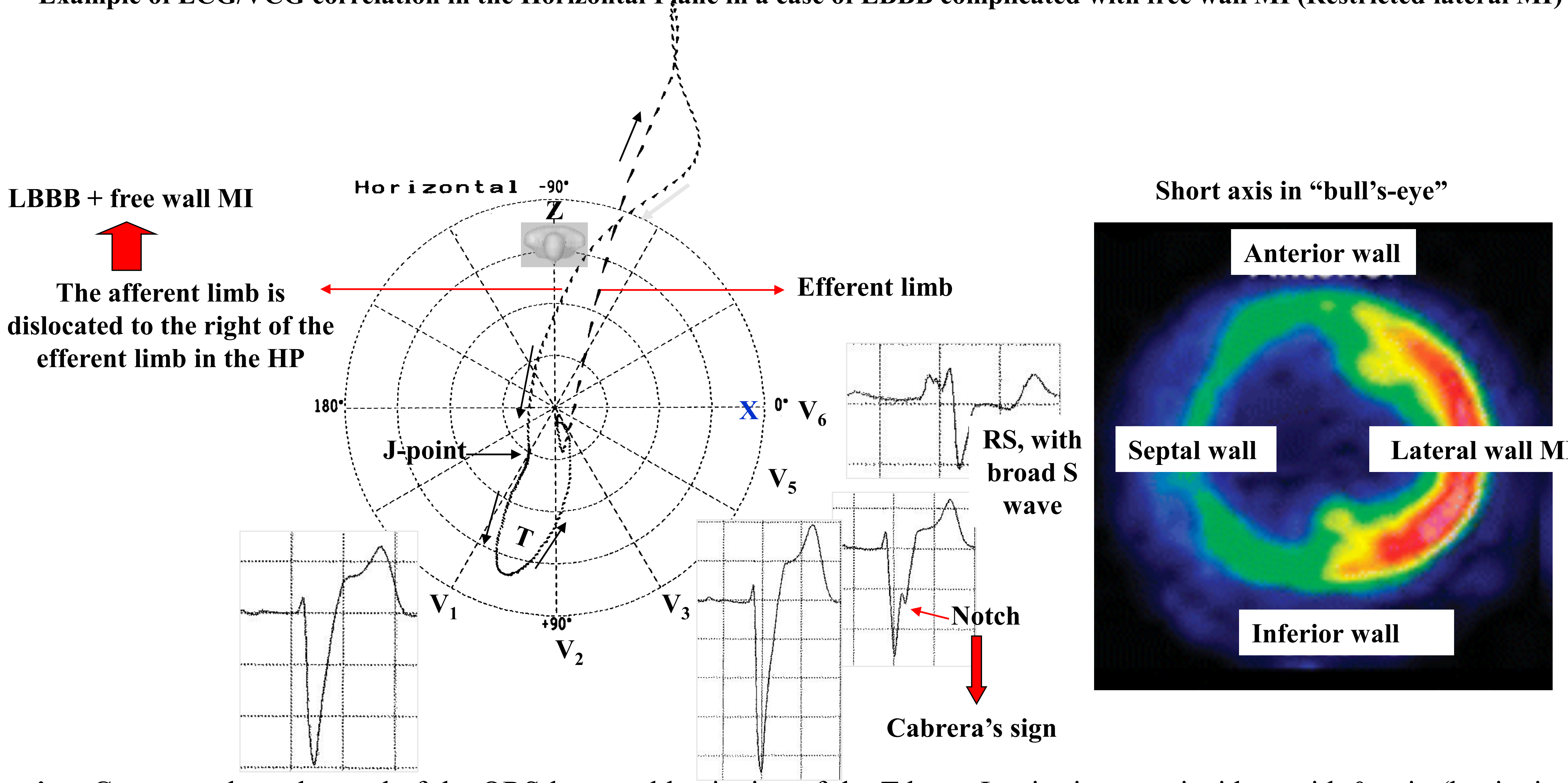
Vector of initial 10 ms to the front and below, QRS loop of clockwise rotation, QRS loop with characteristic middle final delay, direction of maximal vector of posterior orientation (175º), T loop of location opposite to the QRS loop (anterior) and of clockwise.

LBBB associated with myocardial infarction of the free wall of the left ventricle or isolated lateral MI



The lateral wall of the LV is supplied by branches of the left anterior descending (LAD) and left circumflex (LCx). Isolated lateral STEMIs are less common, but may be produced by occlusion of smaller branch arteries that supply the lateral wall, e.g. the first diagonal branch (D1) of the LAD, the obtuse marginal branch (OM) of the LCx, or the ramus intermedius.

Example of ECG/VCG correlation in the Horizontal Plane in a case of LBBB complicated with free wall MI (Restricted lateral MI)



J-point: Corresponds to the end of the QRS loop and beginning of the T-loop. J-point is not coincident with 0 point(beginning of QRS loop. The T-loop is located opposite related QRS loop and has efferent and afferent limbs with uniform slow conduction speed (abnormal). Additionally, its shape frequently is rounded and small or broad such us the present case.

Table that shows the ECG/VCG differences between uncomplicated LBBB and LBBB associated with lateral MI or isolated lateral MI

	Uncomplicate LBBB	LBBB associated with lateral MI
QRS loop on HP	CW rotation, The magnitude of the max QRS vector is increased above >2 mV	CCW rotation. The magnitude of the max QRS vector >2 mV
Left leads pattern I, aVL, V5-V6	Wide R pure only. Sometimes in aVL qR	RS or Rs may appear. S≥ 40ms and frequently with notched
Afferent/efferent limb relationship of QRS loop in the HP	Th efferent limb is located to the right of the afferent limb.	The afferent limb is dislocated to the right of the efferent limb.
Characteristics of T- efferent/afferent lopp limbs	Efferent limb with slow conduction related afferent one and whit elongated, narrow or linear shape.	Efferent and afferent t limb with slow conduction and shape frequently rounded and small.
T wave in left leads	Positive and asymmetrical	Usually negative e symmetric
T-loop in HP	Elongated with afferent and efferent limb with different speed. Elliptical or linear aspect, inscribed clockwise and with slow inscription of the efferent limb and rapid inscription of the afferent limb, directed away from the terminal vectors of the QRS loop.	T-loop opposite related QRS loop with uniform conduction speed (abnormal).and frequently rounded and small.

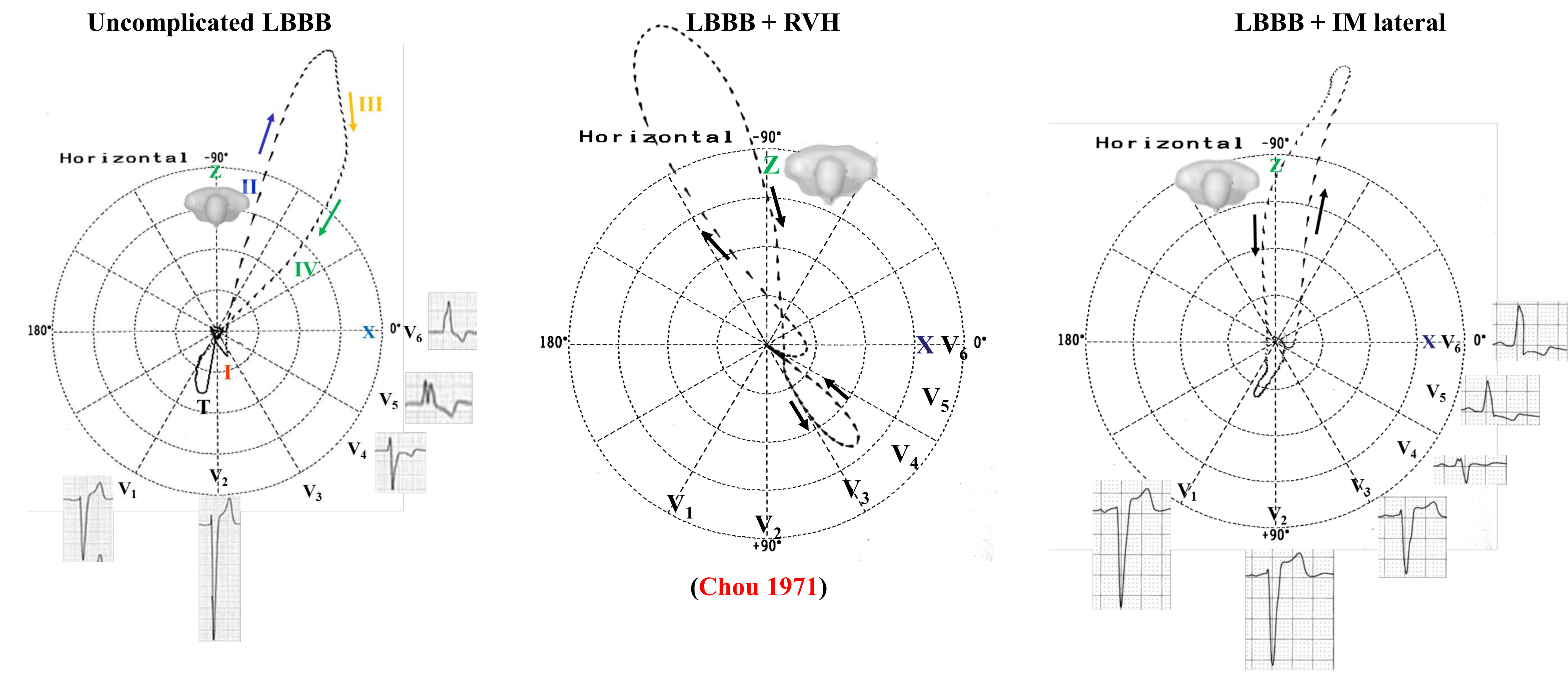
Possible significance of final S waves in left leads (RS or rS pattern) in the presence of LBBB

I. **Precordial QRS late transition pattern in V_5 and V_6:** R-wave progression or RS ratio in left precordial leads V5-V6. On the Z-axis. an equiphasic QRS complex and this is referred to as the transition lead. This most often occurs in lead V3 but is highly dependent on lead placement. When transition occur in leads V4, V5, or V6 it is referred to as a late transition. gradual increase in the amplitude of the R-wave between leads V1-V4. This is referred to as R-wave progression. Lead V1 may or may not have an initial r wave in cases of CLBBB, but one should show up by lead V2 and get a little taller in lead V3 and reach its maximum height in lead V4 or V5. with R pure in V5-V6. Again, this is highly dependent on lead placement.

II. **Association with Right Ventricular Enlargement/Hypertrophy; When LBBB is associated with RVH** in left leads na wide RS pattern is observed, and frequently . a dominant S wave in V6 is observed (> 7 mm deep; R/S ratio < 1). See next slide

III. **Association with Left Anterior Fascicular Block;**

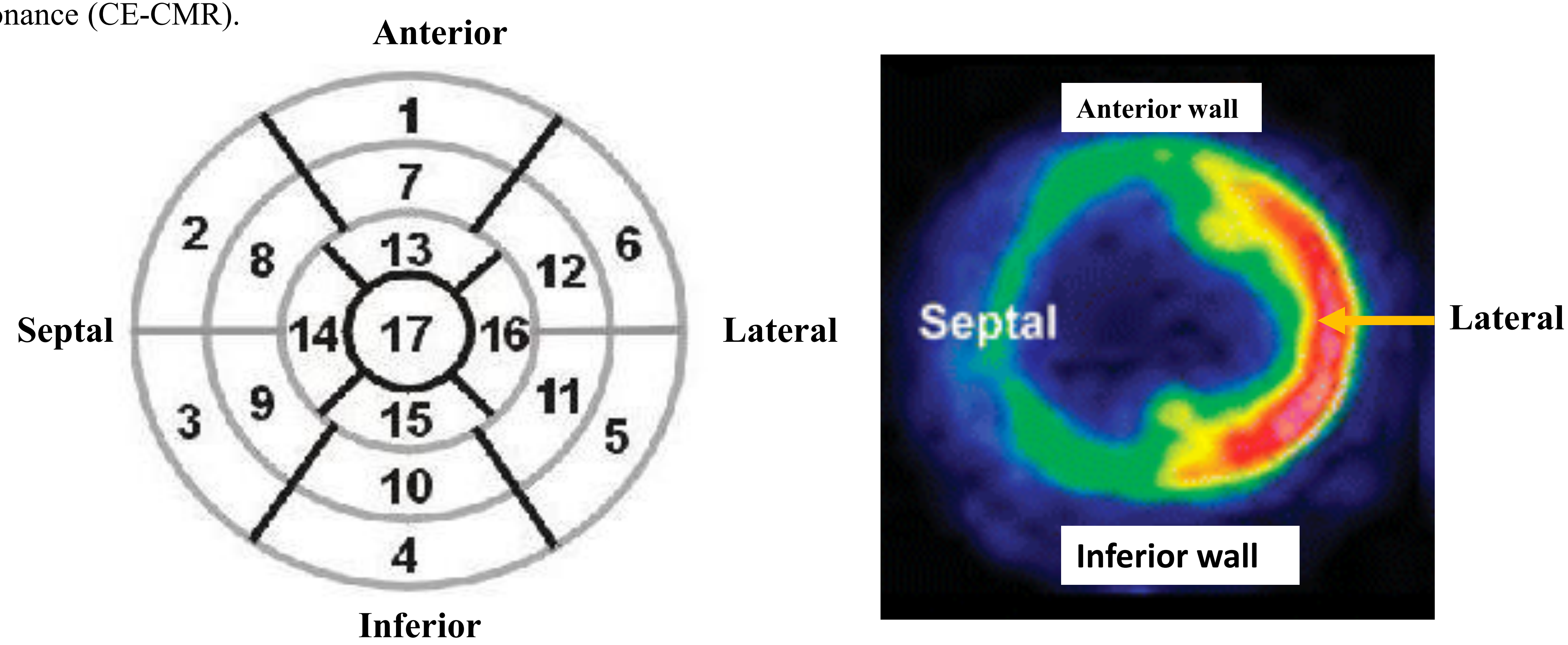
IV. **Association with Free Wall Myocardial Infarction (Lateral Wall MI) (Doucet 1966):** in this case the final S wave in V5-V6 is wide and frequently with notch, and the afferent limb of QRS loop is located to rihgt relate



	Uncomplicated LBBB	LBBB + RVH	LBBB + IM lateral
QRS-loop location of the mayor portion of QRS loop	Left posterior quadrant	Right posterior quadrant	Left and right posterior quadrants with rigthward displacement (**Neuman 1965; Doucet 1966**)
QRS-loop rotation of the mayor portion of QRS loop	CW	CW	CCW

	Uncomplicated LBBB	LBBB + RVH	LBBB + IM lateral
The ST vector and T-loop	Rightward orientation	Leftward orientation	Rightward orientation or intermediate
T-loop shape	Elongated or linear	Elongated or linear	Wide or rounded and small.
Efferent/afferent limbs	Slow/rapid inscription	Slow/rapid inscription	Both with slow inscription
Etiology	Hypertension, CAD, aortic/mitral calcification, Lenègre disease, Lev disease. Cardiomyopathies, myocarditis, after myothomy/myecthomia surgery of Hypertrophic cardiomyopathies, sarcoidosis, amyloidosis and miscellanea's.	RVH Congestive heart failure, chronic pulmonary embolism, ostium primum atrial septal defect, Aortic coartation distal to the left subclavian artery	Lateral infarction: CAD

Left ventricular segmentation wall short axis view Bull's eye plot lateral Myocardial Infarction contrast-enhanced cardiovascular magnetic resonance (CE-CMR).



1 basal anterior

2 basal anteroseptal

3 basal inferior septal

4 basal inferior

5 basal inferolateral

6 basal anterolateral

7 mid anterior

8 mid anteroseptal

9 mid inferoseptal

10 mid inferior

11 mid inferolateral

12 mid anterolateral

13 apical anterior

14 apical septal

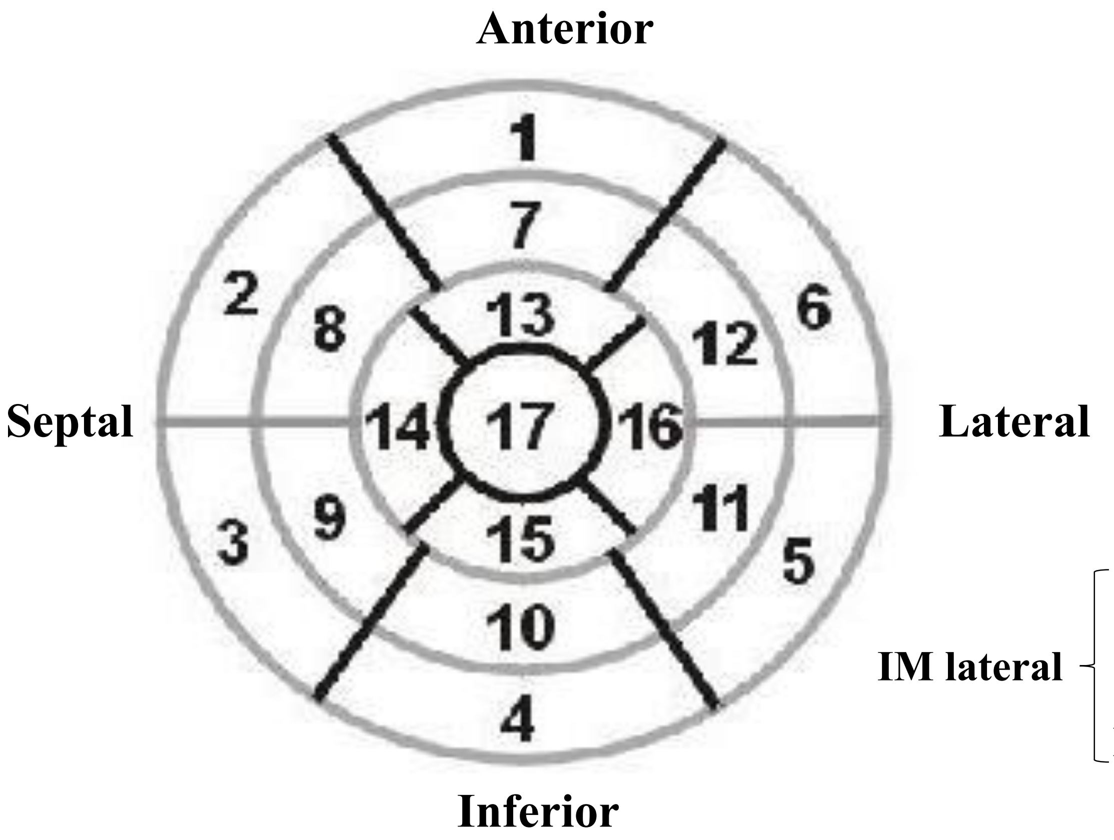
15 apical inferior

16 apical lateral

17 apex

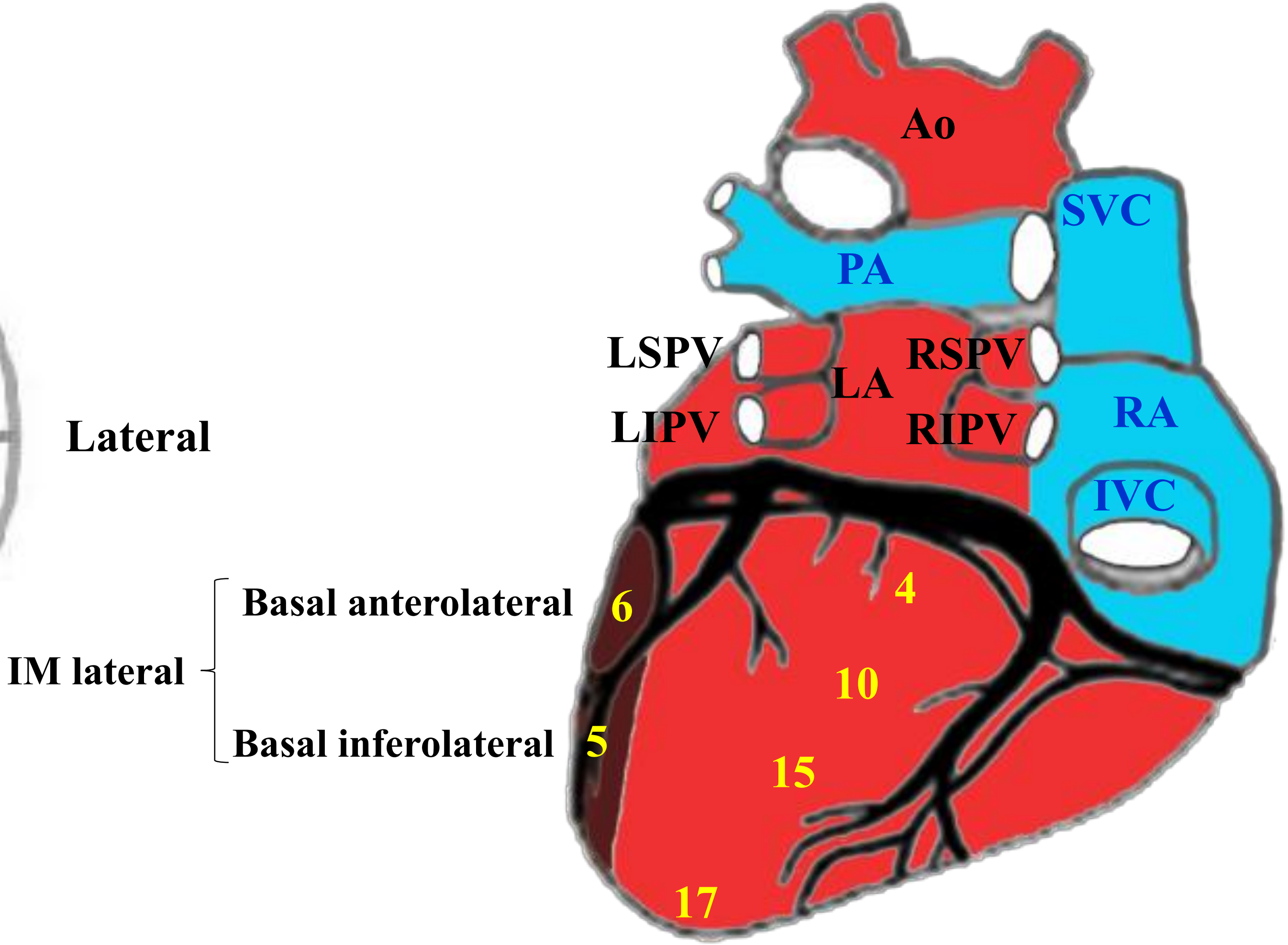
The terms posterior and high lateral infarction are incorrect and should be changed to lateral wall and limited anterolateral wall MI.

Left ventricular segmentation wall short axis view Bull's eye plot



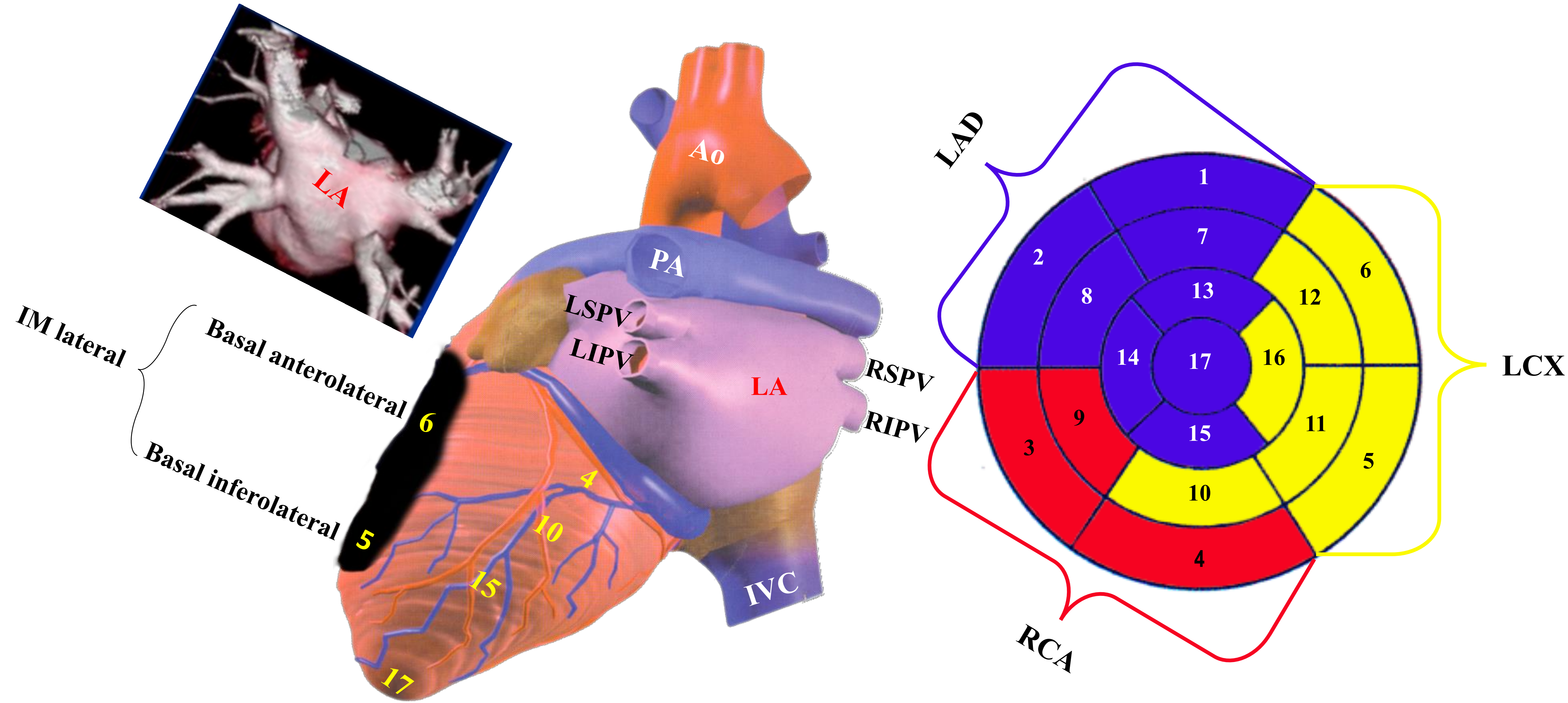
4 basal inferior (old dorsal)
10 mid inferior
15 apical inferior
17 apex

Posterior view of the heart



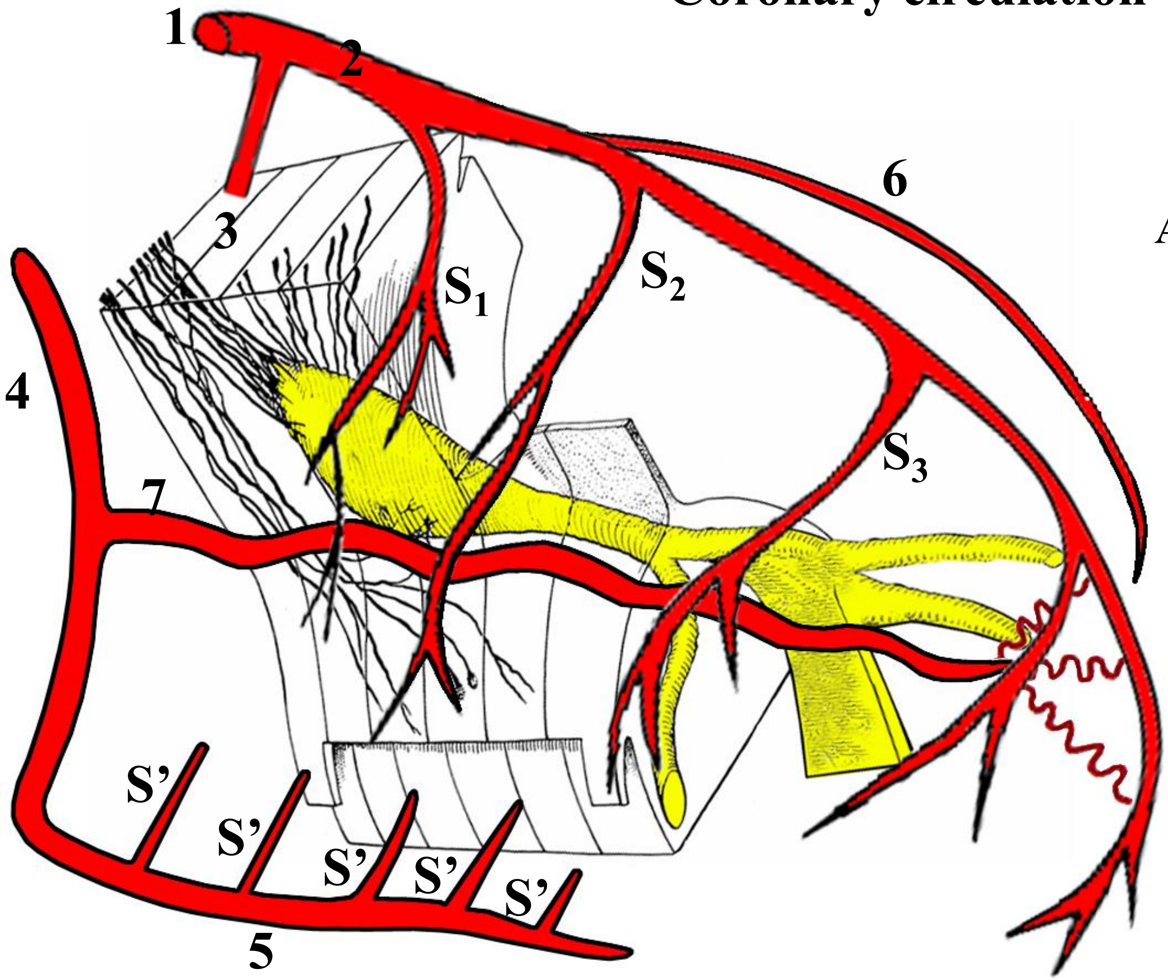
Ao: Aorta; IVC: Inferior Vena Cava; LA: Left Atrium; LIPV: Left Inferior Pulmonary Vein; LSPV: Left Superior Pulmonary Vein; PA: Pulmonary Artery; RA: Right Atrium; RIPV: Right Inferior Pulmonary Vein; RSPV: Right Superior Pulmonary Vein; SVC: Superior Vena Cava

Left posterior oblique view of the heart and Bull'eye plot in 17-segment model



Ao: Aorta**; IVC**: Inferior Vena Cava; LA: Left Atrium; : Left Inferior Pulmonary Vein; **LSPV:** Left Superior Pulmonary Vein; **PA**: Pulmonary Artery; **RIPV:** Right Inferior Pulmonary Vein; **RSPV:** Right Superior Pulmonary Vein; SVC: Superior Vena Cava ; **LAD:** Left Anterior Descending artery; **RCA:** Right Coronary Artery**; LCX :** Left Circumflex. Segment 4 is inferior basal (old dorsal). Dorsal wall does not exist (**Bayés de Luna 2006**).

Coronary circulation



Anterior Septal Perforator Branches

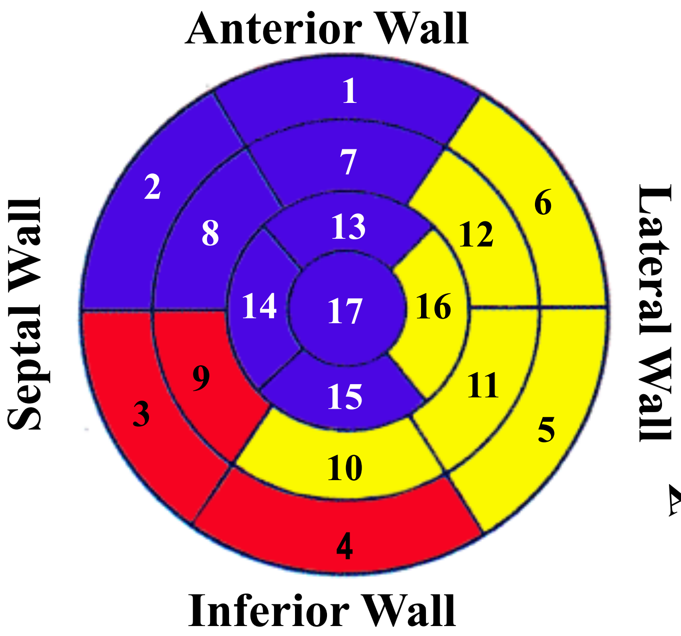
S_1: First Septal Perforator branch
S_2: Second Septal Perforator
S_3: Third Septal Perforator

S': Posterior Septal Perforators

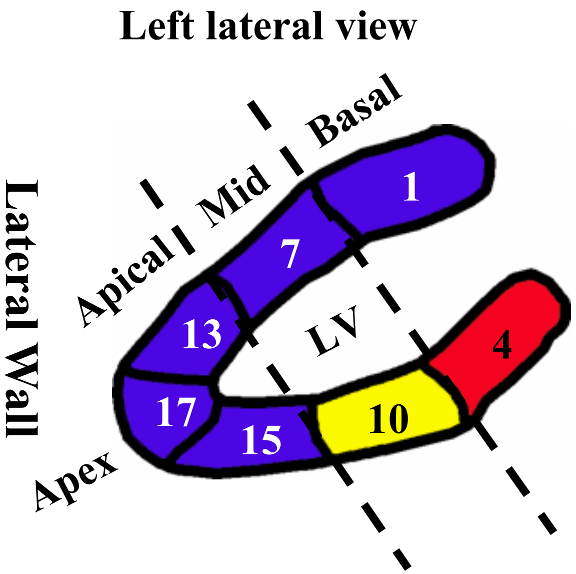
1. Left Main Coronary Artery **(LMCA)**
2. Left Anterior Descending Artery (**LAD)**
3. Left Circumflex Coronary Artery (**LCX)**
4. Right Coronary Artery (**RCA)**
5. Posterior Descending Artery (**PDA**). In this case is supplied by the RCA, then the coronary circulation can be classified as "right-dominant“
6. First Diagonal (**Dg**)
7. Acute Marginal (**A. Mg)**

Ventricular segmentation heart walls with contrast-enhanced cardiovascular magnetic resonance (CE-CMR)

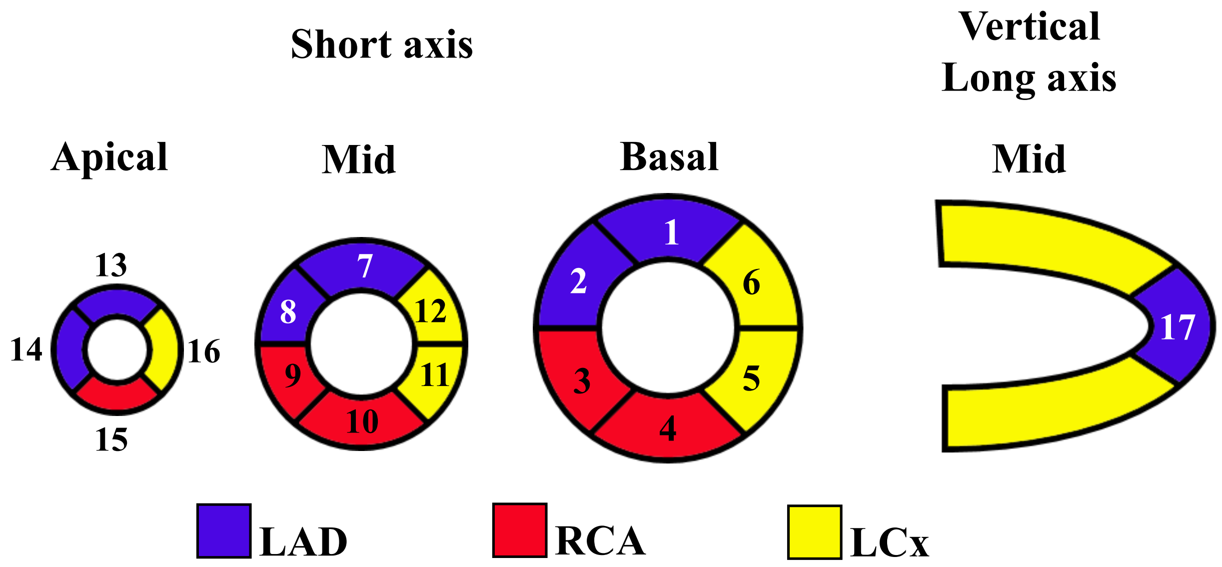
Polar map short axis in "bull's-eye"



Left lateral view



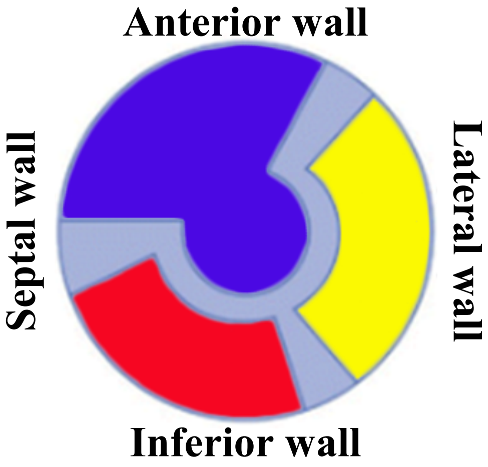
Coronary artery territories



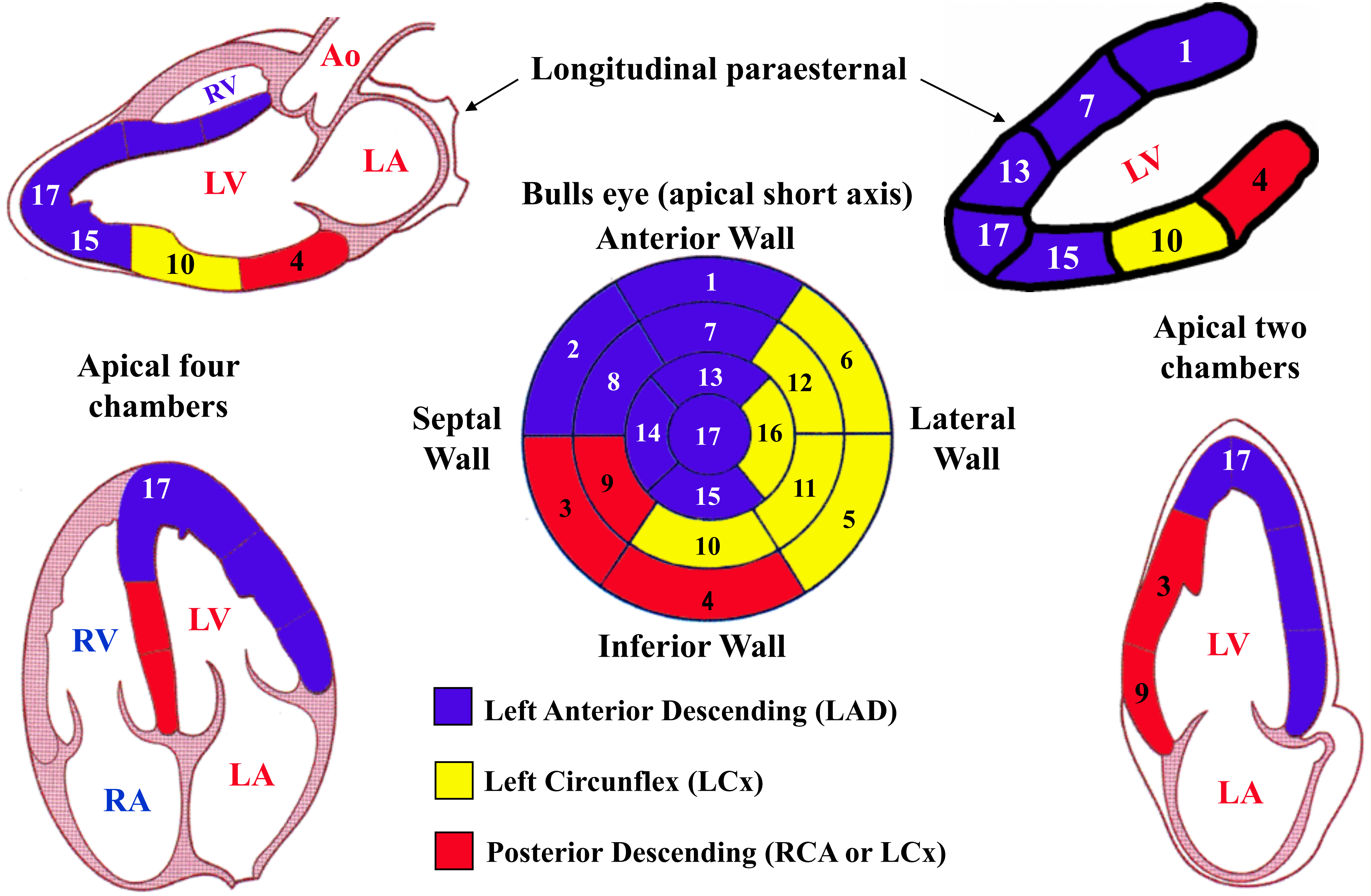
17 myocardial segments and the recommended nomenclature for tomographic imaging of the heart. Data from the individual short-axis tomograms can be combined to create a polar map plot, representing a 2D compilation of all the 3D short-axis perfusion data. Standard nomenclature for the 17 segments is outlined.

The 17 myocardial segments to the territories of the LAD, RCA, and LCx. The 2D compilation of perfusion data can then easily be assigned to specific vascular territories (**Dilsizian 2013**).

1. Basal anterior
2. Basal anteroseptal
3. Basal inferoseptal
4. Basal inferior
5. Basal inforolateral
6. Basal anterolateral
7. Mid anterior
8. Mid anteroseptal
9. Mid inferoseptal
10. Mid inferior
11. Mid inferolateral
12. Mid anterolateral
13. Apical anterior
14. Apical septal
15. Apical inferior
16. Apical lateral
17. Apex



Left Ventricle myocardial segmentation, standard standard 17-segment model, and vascular territories



The apex is analyzed separately, usually from a vertical long-axis slice.

In uncomplicated LBBB the T loop or secondary abnormalities of T-loop, the ventricular gradient is normal although the QRS-T angle may be abnormally wide. The alteration of repolarization is directly dependent upon a change in the sequence of depolarization.

In vectorcardiography the ST vector is the vector joining the **0** point or origin of the QRS loop to the **J** point which marks the beginning of the T loop. This vector is due to onset of ventricular repolarization prior to the completion of inscription of the QRS loop and is represented on the planar VCG by a failure of the QRS loop to close. The magnitude of this vector is usually less than **0.1mV** but may rarely be ≥**0.4mV** in the following circumstances:

1) Early repolarization syndrome
2) Brugada Syndrome
3) Cancelled forms of ARVC/D
4) Short QT syndrome
5) Idiopathic ventricular fibrillation
6) Myocardial aneurysm in late period post-myocardial infarction of the left ventricle and in the acute myocardial injury.

The normal QRS loop in uncomplicated LBBB is located in left posterior quadrant, has elongated and narrow shape, the efferent limb located to left related afferent limb and has CCW rotation (inversion related to uncomplicated LBBB). The afferent limb is located on right posterior quadrant.

The ischemic T-loop in LBBB is opposite related QRS loop with uniform conduction speed (abnormal) and frequently rounded and small.

The normal T loop in uncomplicated LBBB has an elliptical, narrow or linear aspect, inscribed clockwise(CW) with slow inscription of the efferent limb and rapid inscription of the afferent limb(normal asymmetrical), and directed away from the terminal vectors of the QRS loop.

Conclusion: LBBB associated with lateral MI

References

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