Dear Andrés: what is your diagnosis of this ECG?

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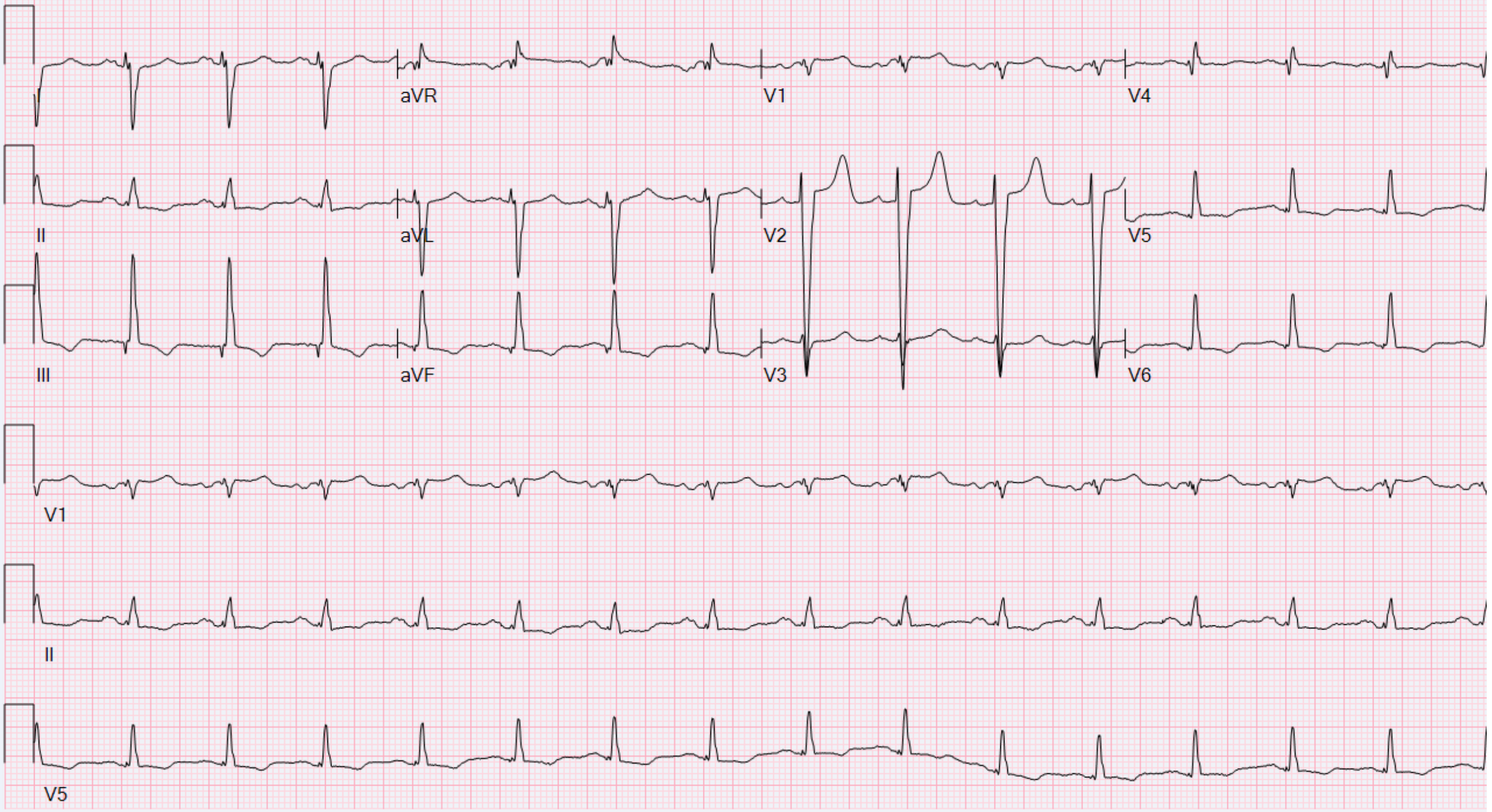
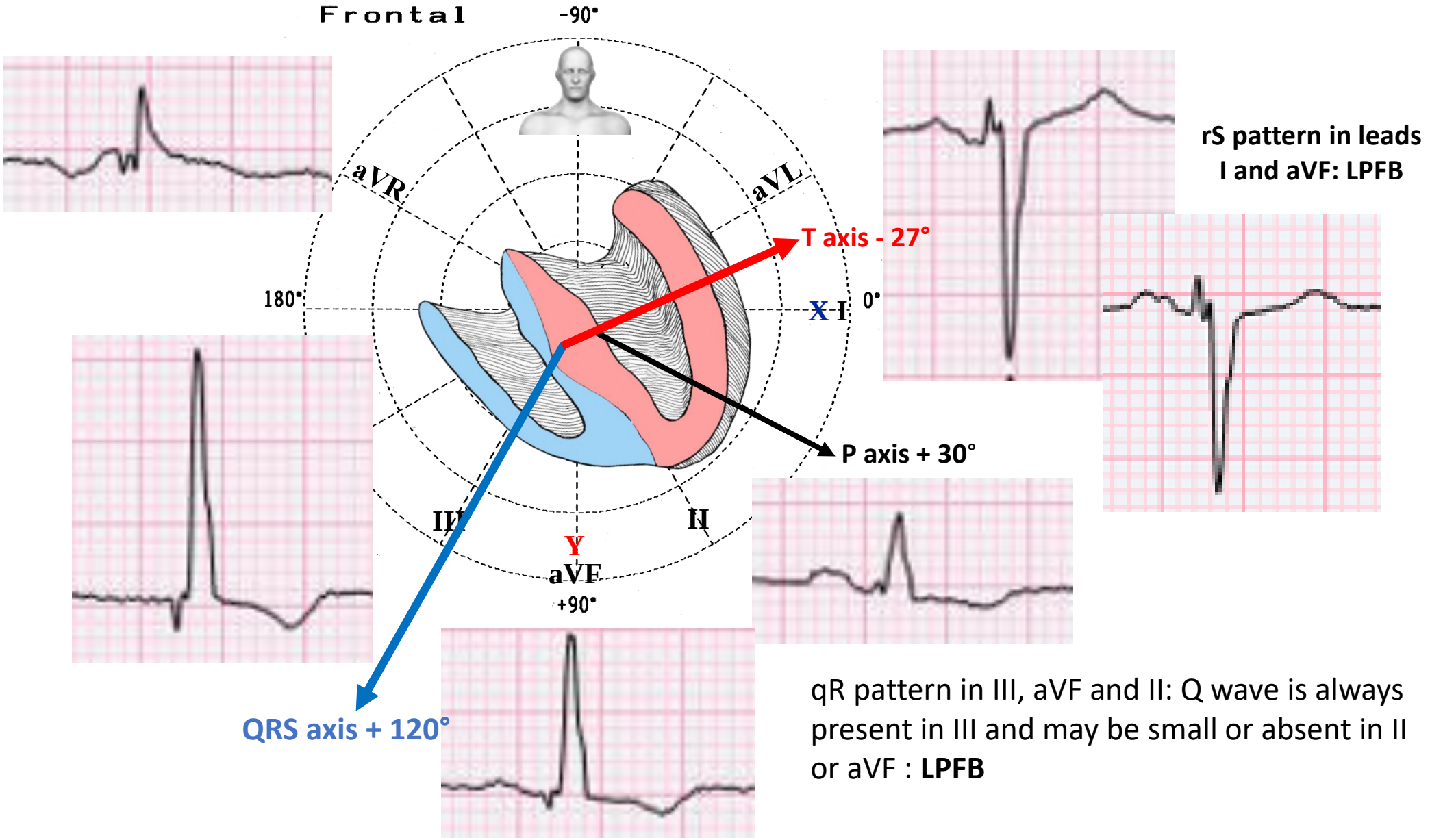

aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1
II
V5

Prof. Dr. Andrés Ricardo Pérez-Riera M.D. Ph.D.

ECG analysis

Laboratório de Metodologia de Pesquisa e Escrita Científica, Centro Universitário Saúde ABC, Santo André, São Paulo, Brazil.

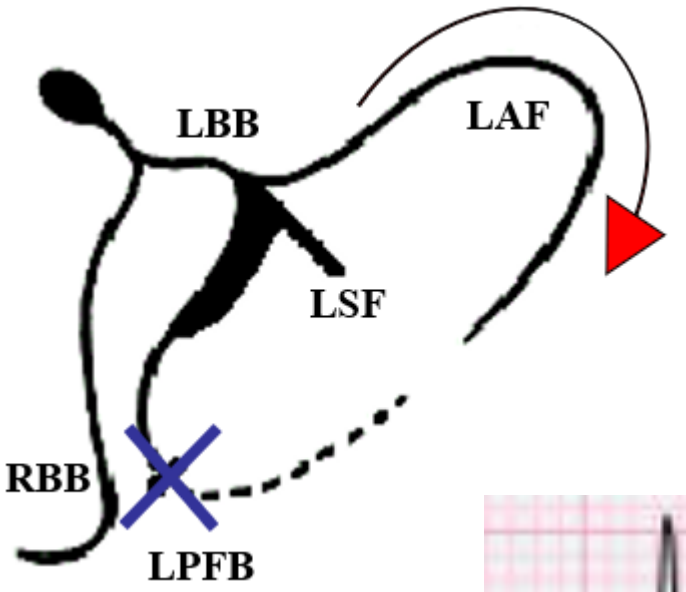


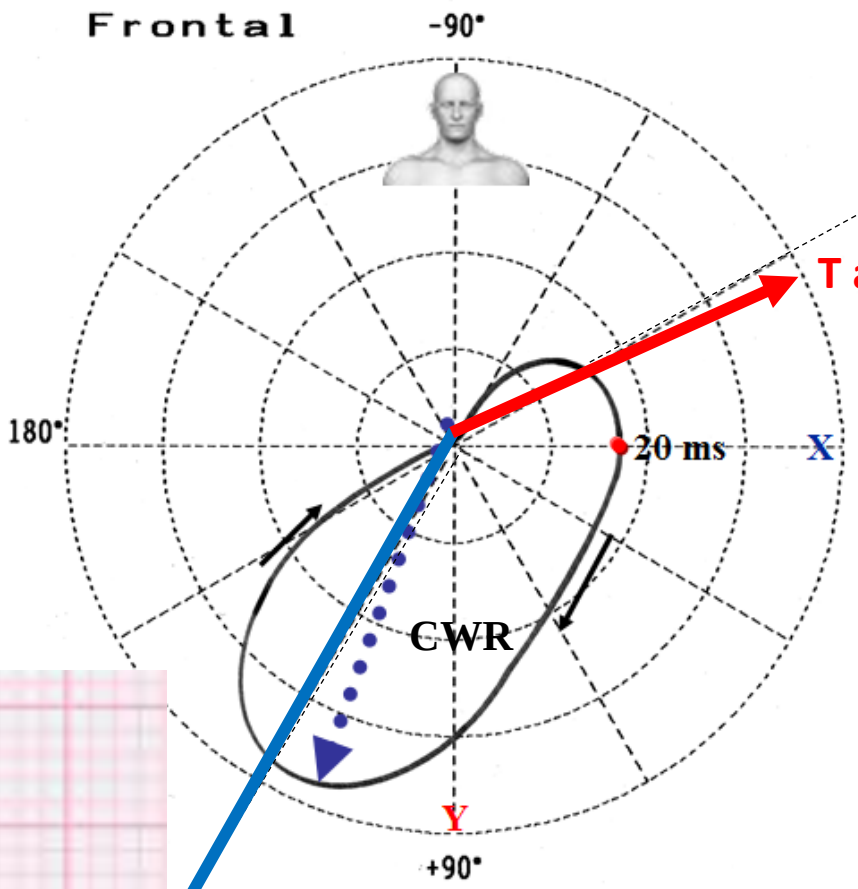
rS pattern in leads I and aVF: LPFB

qR pattern in III, aVF and II: Q wave is always present in III and may be small or absent in II or aVF : **LPFB**

The q wave in III is greater than the q wave in II and aVF= **LPFB**

Prolonged (115ms) and bimodal P-wave, P axis + 30°: Left Atrial Enlargement, broad QRS/T angle : LVH with strain.





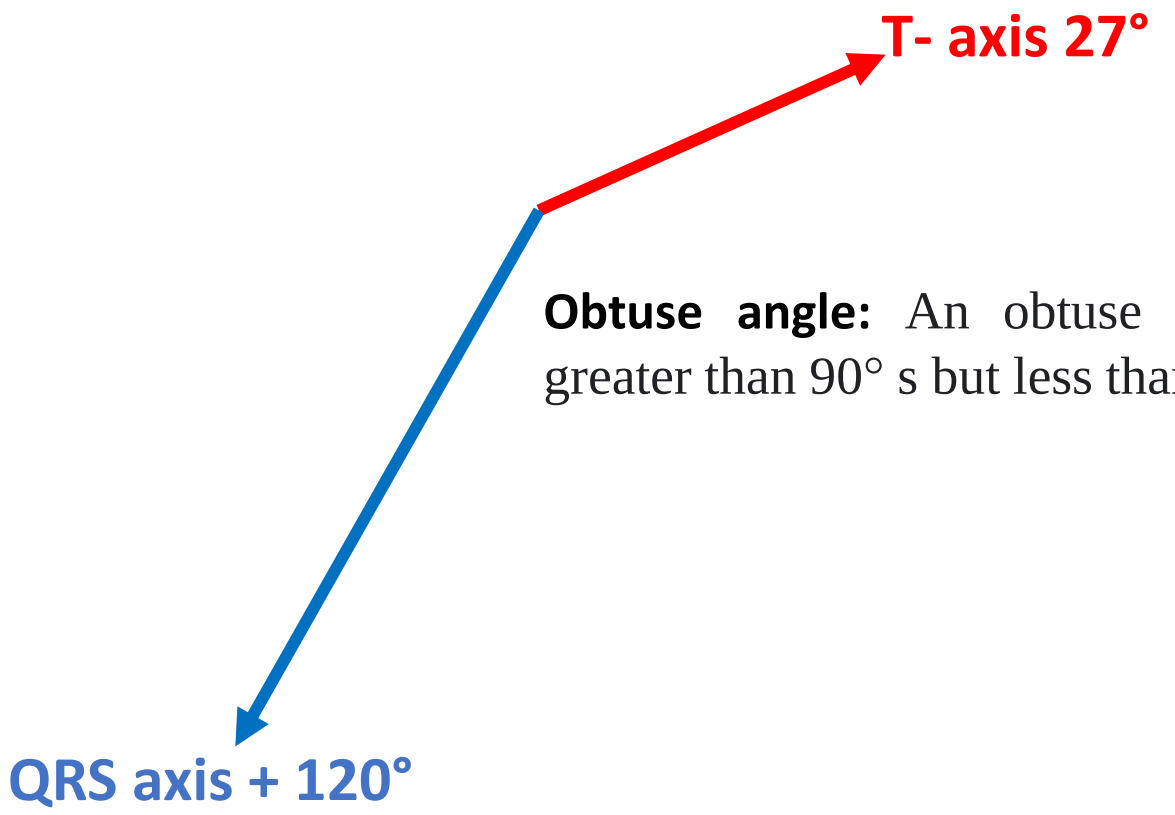
T axis - 27°

rS pattern in leads I and aVF: LPFB

QRS axis + 120°

P wave duration: ≥ 110 ms in adults, ≥ 120 ms in seniors, and 90 ms in children. Specificity: 90% and sensitivity: 40% in old age for LAE

Wide QRS-T angle on the 12-lead ECG is Predictor of Sudden Death beyond the LV Ejection Fraction



Obtuse angle: An obtuse angle has a measurement greater than 90° s but less than 180 °.

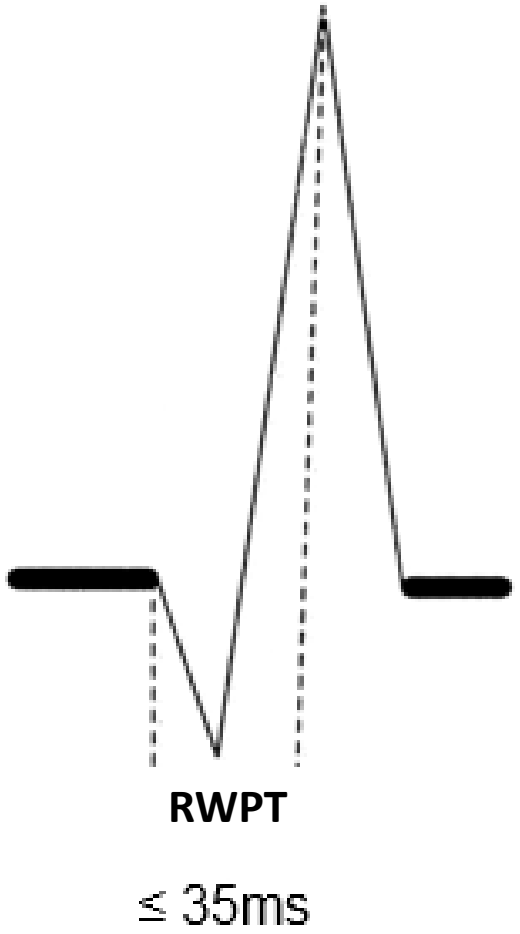
A wide QRS-T angle greater than 90° is associated with an increased risk of SCA independent of the left ventricular ejection fraction.1

1. **Kelvin C M Chua, et al. Wide QRS-T Angle on the 12-Lead ECG as a Predictor of Sudden Death Beyond the LV Ejection Fraction. J Cardiovasc Electrophysiol. 2016 Jul;27(7):833-9. doi: 10.1111/jce.12989.**

Fragmented QRS (fQRS) is a convenient marker of myocardial scar evaluated by 12-lead ECG recording. fQRS is defined as additional spikes within the QRS complex. In patients with CAD, fQRS was associated with myocardial scar detected by single photon emission tomography and was a predictor of cardiac events. fQRS was also a predictor of mortality and arrhythmic events in patients with reduced left ventricular function. The usefulness of fQRS for detecting myocardial scar and for identifying high-risk patients has been expanded to various cardiac diseases,

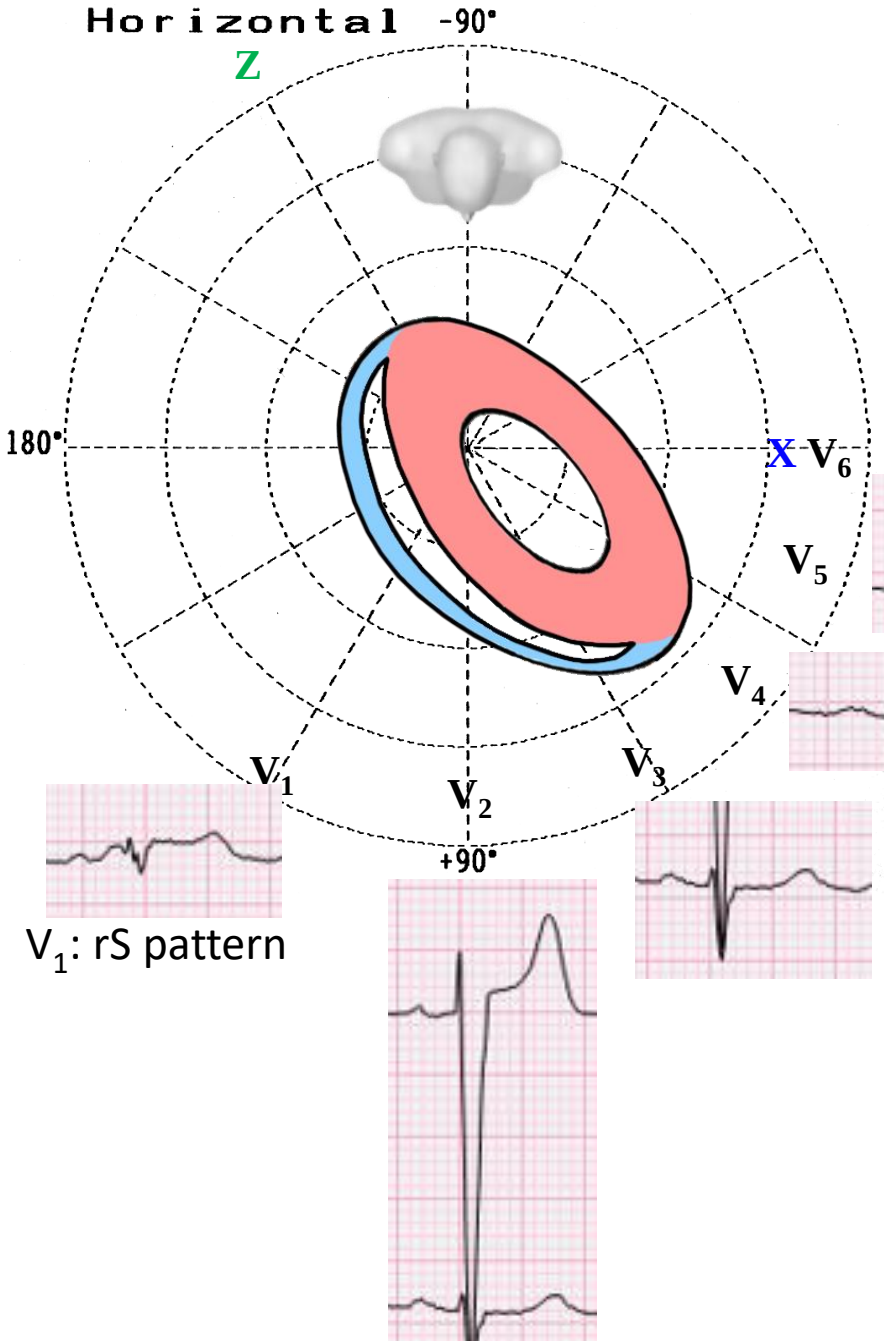
Prolonged ventricular activation time or R-Wave Peak Time in aVF

Slur in the descending limb of the R wave in aVF (middle-final Slur/Notch): LPFB criteria pseudo J-wave



When LPFB is associated with inferior myocardial infarction, the initial Q wave has a duration ≥ 40ms
Prolonged Ventricular Activation Time (VAT) or R-Wave-Peak Time (RWPT)

1. **Rusconi, A Nava, S Sermasi, G E Antonioli. The left posterior fascicular block: is the diagnosis possible only by ECG? G Ital Cardiol. 1980;10(9):1129-34.**



Strain pattern: **LVH**

Scant progression of growth of r wave in precordial leads **LPFB.**

V_1: rS pattern

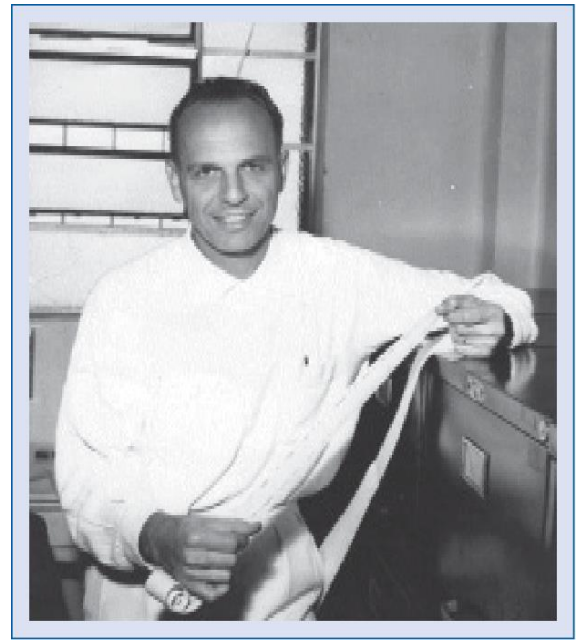
S wave of V_2 very deep consequence of posterior dislocation of the final QRS forces: **LPFB.**

Penaloza and Tranchesi sign: QRS complexes of low voltage in V_1 contrasting with QRS complexes normal or increased voltage in V_2.

It is considered and indirect criteria of right atrial enlargement1.

V_1 3mm vs V_2 30mm

Dr. Dante Peñaloza Ramella2



_Prof. Dr. João Tranchesi3

1. Tranchesi J. Eletrocardiograma normal e patológico: noções de vectorcardiografia. 2nd ed. São Paulo: Atheneu; 1963, p. 411.
2. Jorge Luis Sotomayor-Perales, Edgardo Schapachnik, Raimundo Barbosa-Barros, Andrés Ricardo Pérez-Riera A tribute in life to the world icon of the cardiology of heights: Dr. Dante Peñaloza from Peru. J Electrocardiol. May-Jun 2018;51(3):496-498. doi: 10.1016/j.jelectrocard.2018.01.001
3. A. P. Riera, A. Uchida. Prof. Dr. João Tranchesi: chronology of a fruitful life, 8 February 1922 - 12 October 1978. Cardiol J . 2010;17(2):211-3.

Conclusion

1. ***Left Atrial Enlargement or biatrial enlargement (Penaloza-Tranchesi sign)***
2. ***Left Ventricular Enlargement with Strain pattern***
3. ***Isolated LPFB in both planes (absence of RBBB in association) VERY RARE***
4. ***f-QRS.***
5. ***Inferior MI?***
6. **Wide QRS-T angle**

Left Posterior Fascicular Block (LPFB): possible causes (Pryor 1971; Elizari 2007; Hecht 1973; Nishida 2007; Rosenbaum 1973)

It is the most rare block of all intraventricular blocks. Very rare without association with others blocks.

1) Coronary artery disease (**Rizzon 1975**): LPFB is a rare but clinically important intraventricular conduction disturbance. Its appearance is reliably connected with IMI and generally reflects severe three-vessel CAD, requiring invasive investigation (**Godat 1993 ; Janion 2007**).

(2a) During the acute phase of ischemia (**Patenè 2009**). Or transient during exercise treadmill testing (**Madias 1999**).

(2b) During the acute phase of infarction: 0.2% to 0.4% (**Demoulin 1979**). A case of transient LPFB and various intraventricular conduction disturbances associated with acute anterolateral infarction was reported by Ogawa et al (**Ogawa 1976**).

(2c) LPFB and latero roinferior myocardial infarction accounted for Q waves in leads II, III and aVF. However, R amplitude in these same leads is increased after LPFB but decreased after lateroroinferior myocardial infarction. The mean QRS axis in the frontal plane was shifted toward the vertical in LPFB but little changed or shifted slightly away from the vertical in posteroinferior myocardial infarction. When LPFB and posteroinferior myocardial infarction coexist, there may be masking, imitation or enhancement of the effects of one lesion by the presence of the other (**Watt 1982**).

3) Lenègre disease, progressive cardiac conduction defect (PCCD) or “idiopathic” sclerosis of the intraventricular His system: by mutation in the SCN5A gene, the same one affecting Brugada Syndrome.

4) Lev disease or progressive idiopathic sclerosis of the “cardiac skeleton”. With a clinical behavior similar to Lenègre disease, however, it occurs in elderly patients;

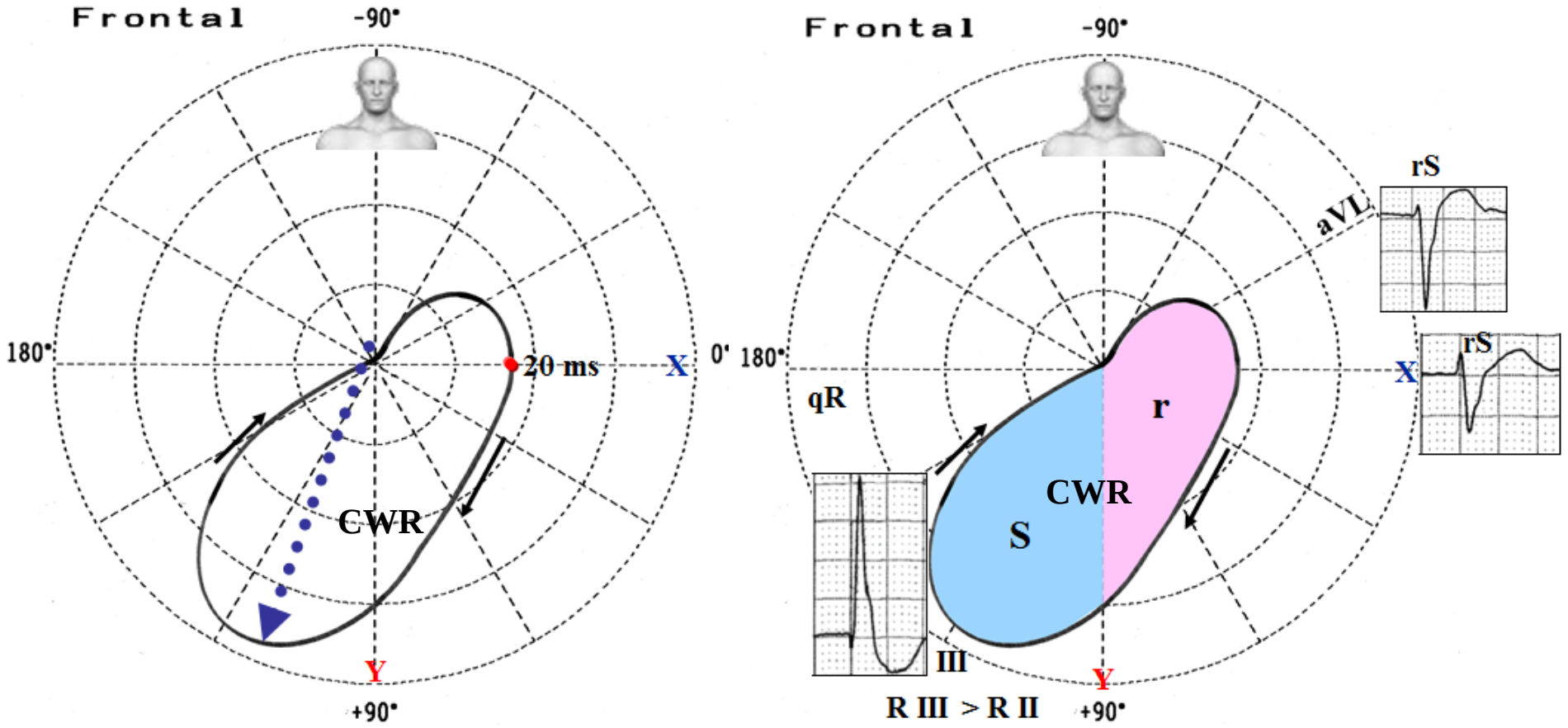
5) Aortic insufficiency: attributed to the mechanical effect of jet regurgitation on the posterior portion of the left septum, the site that the thick LPF goes through (LV inflow tract);

6) Aortic stenosis;

7. Aortic stenosis associated with aortic insufficiency;
8. Supravalvar aortic stenosis;
9. Coarctation of the aorta;
10. Dissecting aortic aneurysm;
11. Massive calcification of the “cardiac skeleton”;
12. Chronic chagasic myocarditis: the most frequent one in Latin America.
13. Cardiomyopathies, myocarditis and infiltrative myocardial diseases;
14. Systemic hypertension;
15. Interventricular septum tumor (**1**)
16. Hyperpotassemia;
17. Transitorily, during contrast injection in the right coronary artery and in Acquired ventricular septal defect: in cases of inferior wall myocardial infarction, complicated by rupture of the inferior septum, resulting in isolated LPFB. (**2**)
18. Acute pulmonary embolism?
19. Hereditary: pseudo LPFB? (**3**).

1. **H Cola 1, R Hoffman, N G Borrega, J O Lazzari. Left posterior hemiblock related to an interventricular septum tumour. First case in the literature. Eur Heart J. 1992 Apr;13(4):574-5. doi: 10.1093/oxfordjournals.eurheartj.a060217.**
2. **Rokey R, Chahine RA.Isolated left posterior fascicular block associated with acquired ventricular septal defect.Clin Cardiol. 1984 Jun;7(6):364-9. doi: 10.1002/clc.4960070608.**
3. **A Lorber 1, E Maisuls, J Naschitz. Hereditary right axis deviation: electrocardiographic pattern of pseudo left posterior hemiblock and incomplete right bundle branch block. Int J Cardiol. 1988 Sep;20(3):399-402. doi: 10.1016/0167-5273(88)90295-1.**

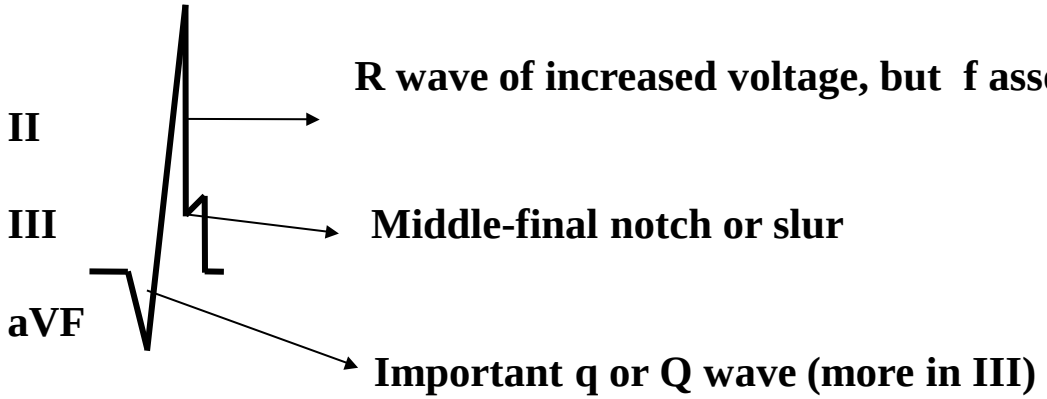
ECG/VCG correlation in LPFB: QRS loop in the FP



Characterization of QRS loop in the frontal plane: Vector of initial 20 ms heading above and to the left; efferent limb to the left; clockwise rotation (CWR); greater area of QRS loop located in the right inferior quadrant; maximal vector heading below and to the right near +110º (from +80º to +140º); QRS loop of "broad" aspect (“fat” loop); afferent limb located in the right inferior quadrant. Typical QRS loop in the frontal plane that explains the rS pattern in I and aVL. Typical QRS in the frontal plane that explains the qR pattern in III with notch in the descending limb of the R wave and R wave in III > R in II. Notch or slur in the descending limb of the R wave in III (middle-final notch).

ECG criteria of LPFB in the Frontal Plane (Palmieri 1974; Medrano 1972)

1) Frontal plane axis between +90 and 180 degree in adults;
2) rS pattern in leads I and aVL
3) qR pattern in III, aVF and II: Q wave is always present in III and may be small or absent in II or aVF.
4) Notch in the descending limb of the R wave in III (middle-final notch);
5) RIII > RII: SÂQRS closer to +120º (III) than +60º (II), when closer to the latter, it would indicate an incomplete form of LPFB.
6) The q wave in III is always greater than the q wave in II and aVF. If there is association with inferior infarction, the Q wave > 40 ms.
7) QRS duration less than 120 ms if isolated (without RBBB)



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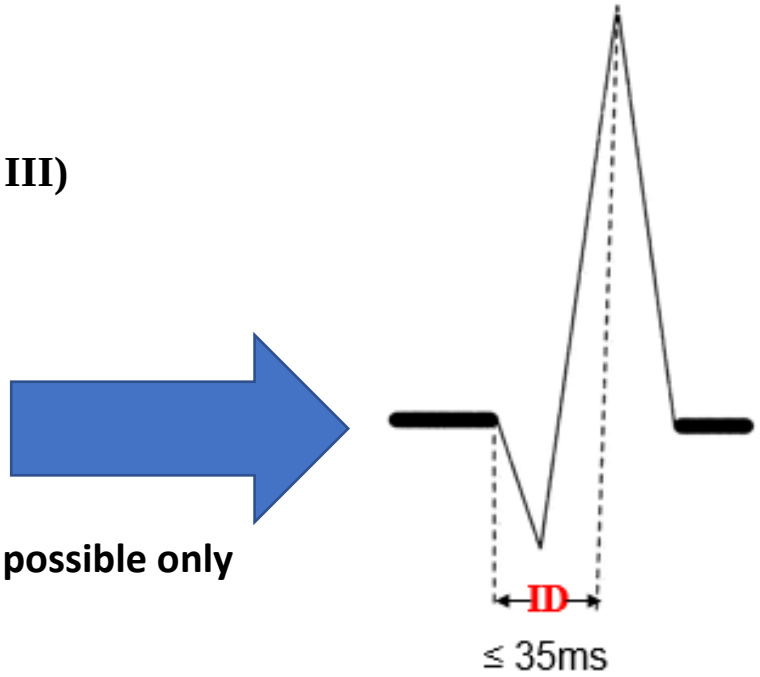
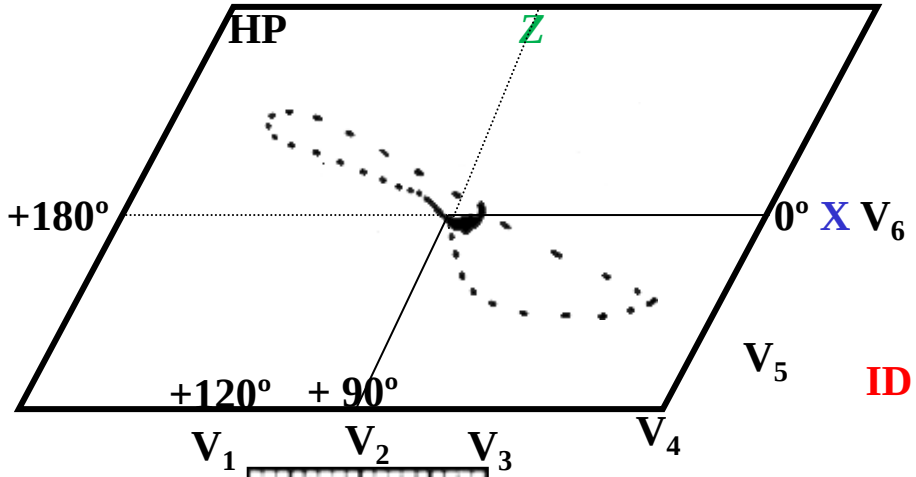
8) Prolonged Ventricular Activation Time, or R-wave peak time in aVF≥35 ms. (Rusconi 1980)

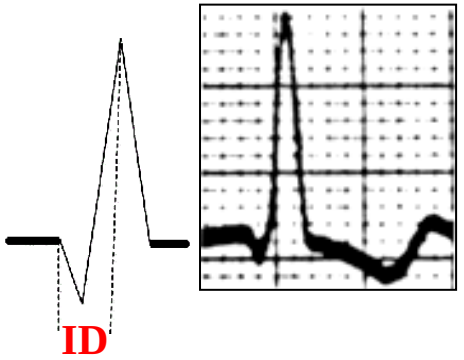


1. **L Rusconi, A Nava, S Sermasi, G E Antonioli. The left posterior fascicular block: is the diagnosis possible only by ECG? G Ital Cardiol. 1980;10(9):1129-34.**

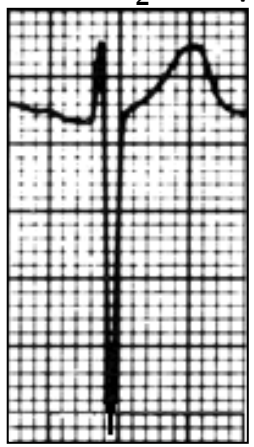
ECG criteria of LPFB in the HP

1) V_1 and V_2: rS pattern, QS rarely.
2) S wave of V_2 -V_3 very deep by posterior dislocation and to the right of the final forces.
3) Scant progression of growth of r wave in precordial leads: dislocation to the left of the transition area.
4) V_5 and V_6: qRs or Rs patterns.
5) Prolonged R-wave peak time of V_5 and V_6 (> 45 ms to 50 ms)
6) Disappearance of q wave in V5 and V6 when LPFB occurs.





ID of V_5 and V_6 > 45 to 50 ms



S wave of V_2 very deep

ECG/VCG correlation of the QRS loop in the horizontal plane related to the V2 and V6 leads. In V2, deep S wave and in V6 intrinsicoid deflection > 45 ms to 50 ms.

VCG criteria for LPFB (1)

Frontal Plane:

- Vector of initial 10 to 20 ms heading above and to the left (near -45°) with possible delay (initial 10 to 25 ms). If associated to inferior infarction, superior initial forces of 25 ms or more (more than 12.5 dashes above the orthogonal X lead. 1 dash = 2 ms) (2).
- Broad QRS loop, with clockwise rotation. Cooksey, Dunn and Massie said that occasionally, it may be in "eight" with a counterclockwise terminal portion (10%).
- Maximal vector near +110º (+80º to +140º)
- Almost all the loop is located below the X line (0 to ±1800) in the inferior quadrants
- 20% of the loop located in the right inferior quadrant. If there is association to CRBBB, 40% or more
- Afferent limb heading below and slightly to the left, and the efferent one to the right.
- Middle-terminal portion of the QRS loop (vector of 60 ms to 100 ms) with delay. It may possibly reach the right superior quadrant
- QRS loop duration up to 110 ms if in isolation. In association to Complete RBBB > 120 ms
- Normal ST-T vectors in isolated LPFB: T loop with clockwise rotation, heading below and to the left. If in association to Complete RBBB: alteration secondary to ventricular repolarization.

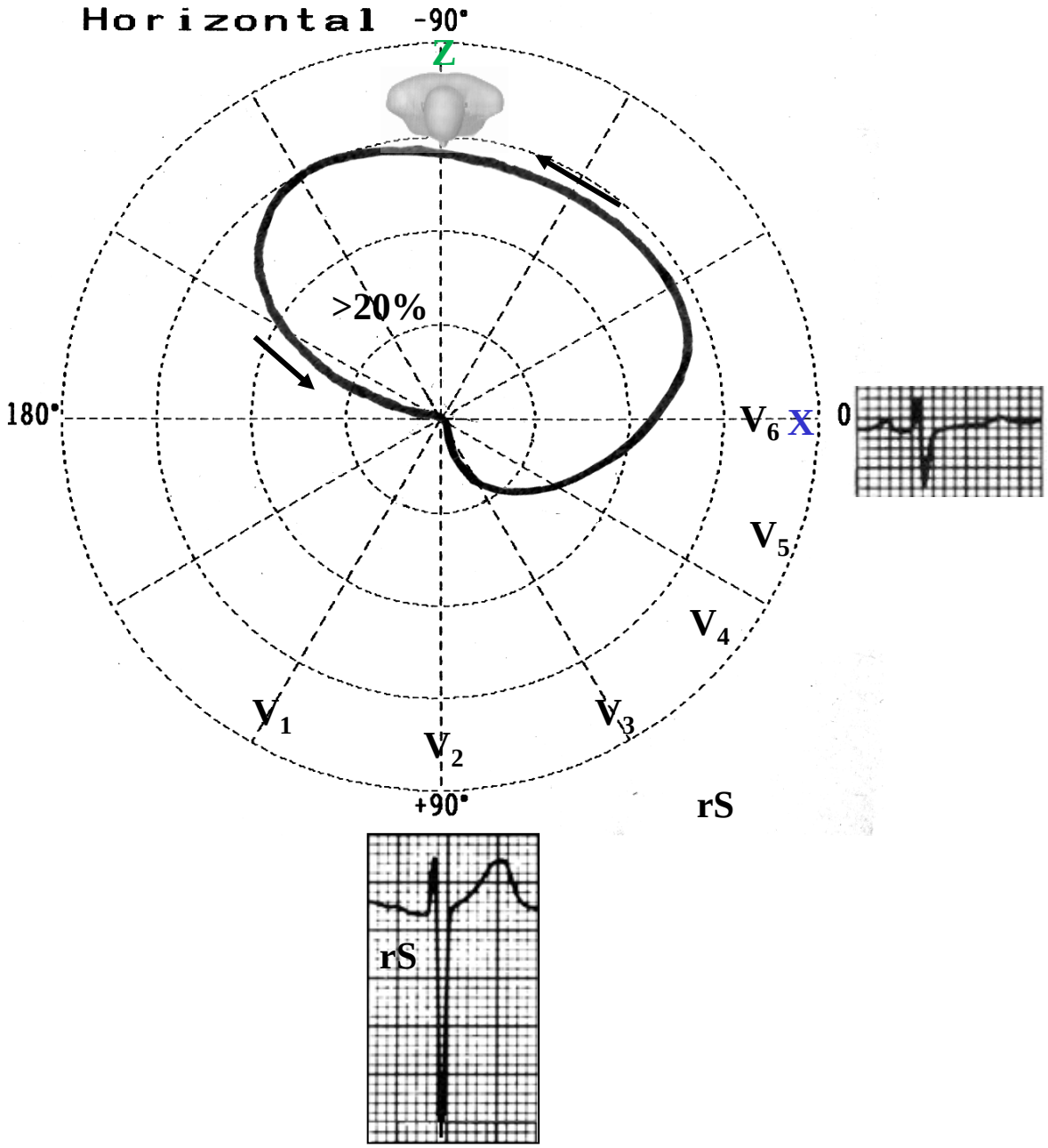
Horizontal Plane:

- QRS loop very similar to RVH of type C;
- QRS loop of counterclockwise rotation. It is admitted that the rotation could be in "eight";
- Vector of initial 10 to 20 ms heading to the front and the right or left;
- Greater area of QRS loop located in the left posterior quadrant;
- Maximal vector of QRS around -60^0 to -110^0;
- Final portions with delay (60 ms to 100 ms) and located in the right posterior quadrant;
- 20% or more of the area of the QRS loop located in the right posterior quadrant;
- T loop to the front and the left ($+60^0$) and clockwise rotation.

1. **C R Brohet, P Arnaud. Spatial Frank vectorcardiogram in left posterior fascicular block. Criteria and correlation with clinical and electrocardiographic data. Br Heart J. 1977 Feb;39(2):126-38. doi: 10.1136/hrt.39.2.126.**
2. **A Castellanos Jr, E Chapunoff, C A Castillo, A G Arcebal, L Lemberg.The vectorcardiogram in left posterior hemiblock associated with inferior wall myocardial infarction.Chest. 1972 Mar;61(3):221-7. doi: 10.1378/chest.61.3.221.**

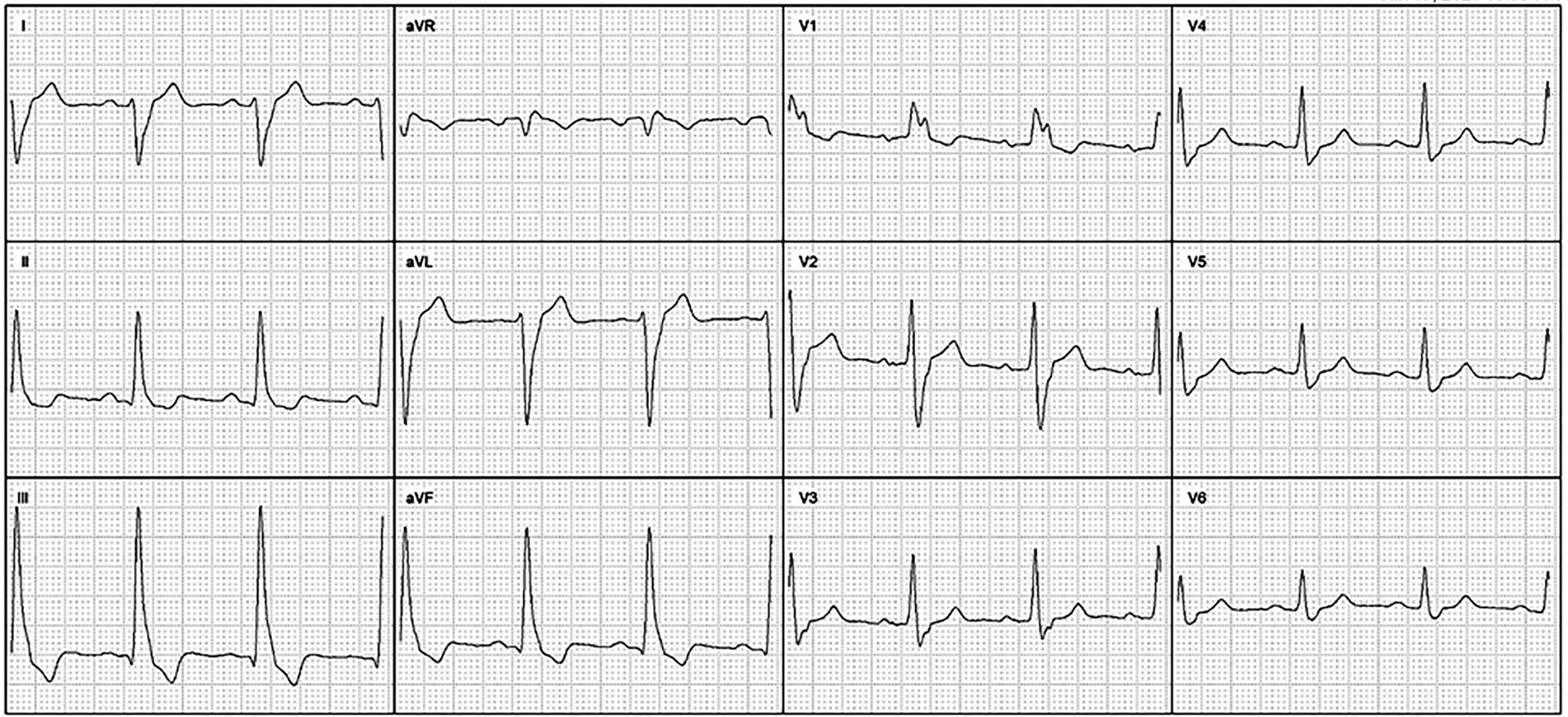
Vectorial representation of QRS loop of ventricular activation in LPFB in the HP

Typical QRS loop in the LPFB in the horizontal plane. The following stand out: vector from the initial 10 to 20 ms heading to the front and the left or right; precordial transition area dislocated to the left; deep S wave in V2 or V2 and V3; frequent RS in left leads V5 and V6; QRS loop similar to RVE type C; QRS loop of CCW rotation; 20% or more of the QRS loop area located in the right posterior quadrant; left precordial leads with RS pattern similar to RVH type C.

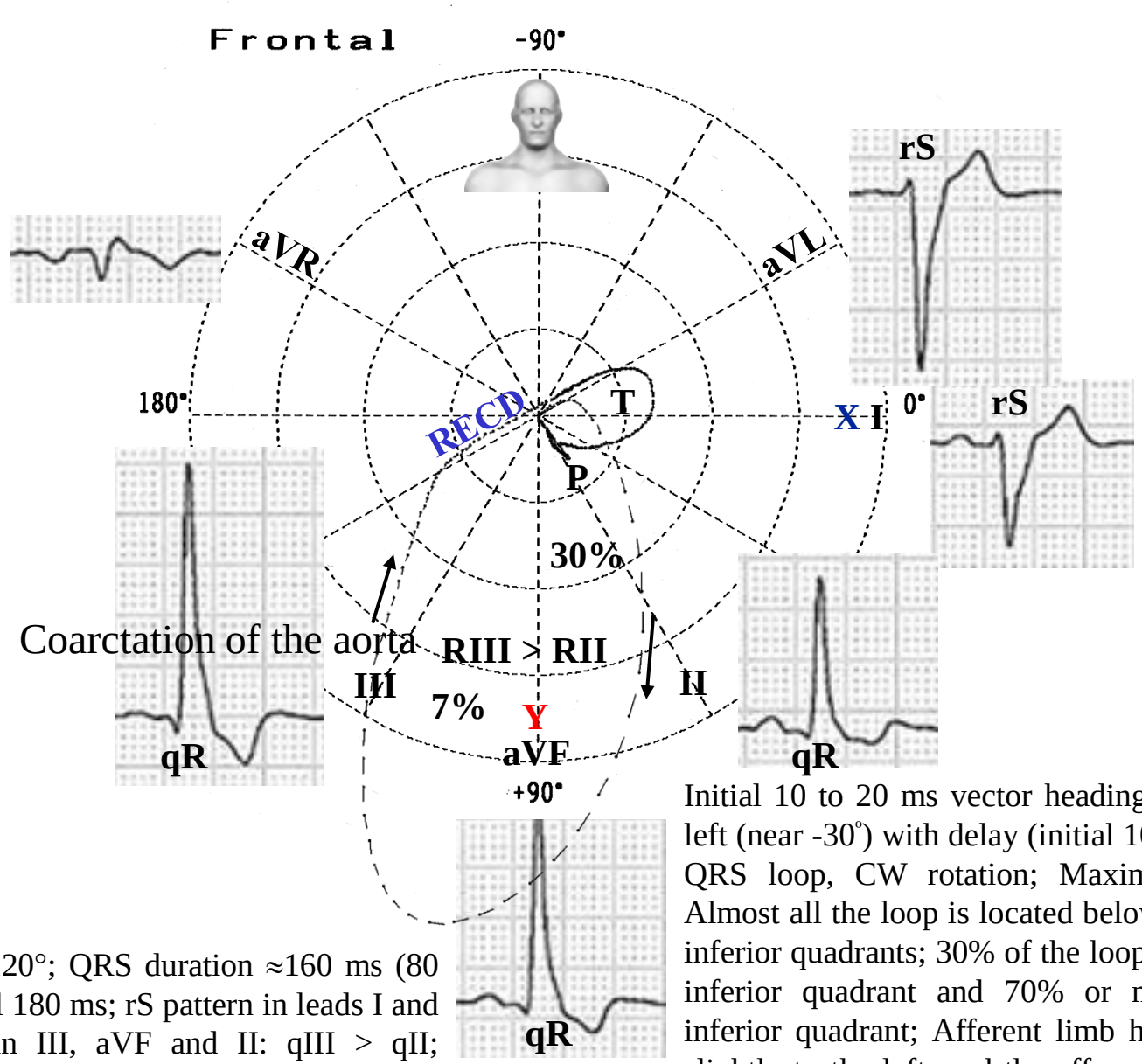


VCG criteria of LPFB in the Sagital Plane (Right and Left)

RSP	LSP
1) Vector of initial 10 to 20 ms to the front and above with possible delay	1) Vector of initial 10 to 20 ms to the front and above with possible delay.
2) Most of the QRS loop located in the infero-posterior quadrant.	2) Most of the QRS loop located in the infero-posterior quadrant.
3) QRS loop of clockwise rotation.	3) QRS loop of counterclockwise rotation.
4) Maximal vector around +120º (+140º to +80º).	4) Maximal vector around +120º (+140º to + 80º).
5) Constant end delay and possible initial delay.	5) Constant end delay and possible initial delay.
6) T loop heading to the front and below with clockwise rotation.	6) T loop heading to the front and below with counterclockwise rotation.



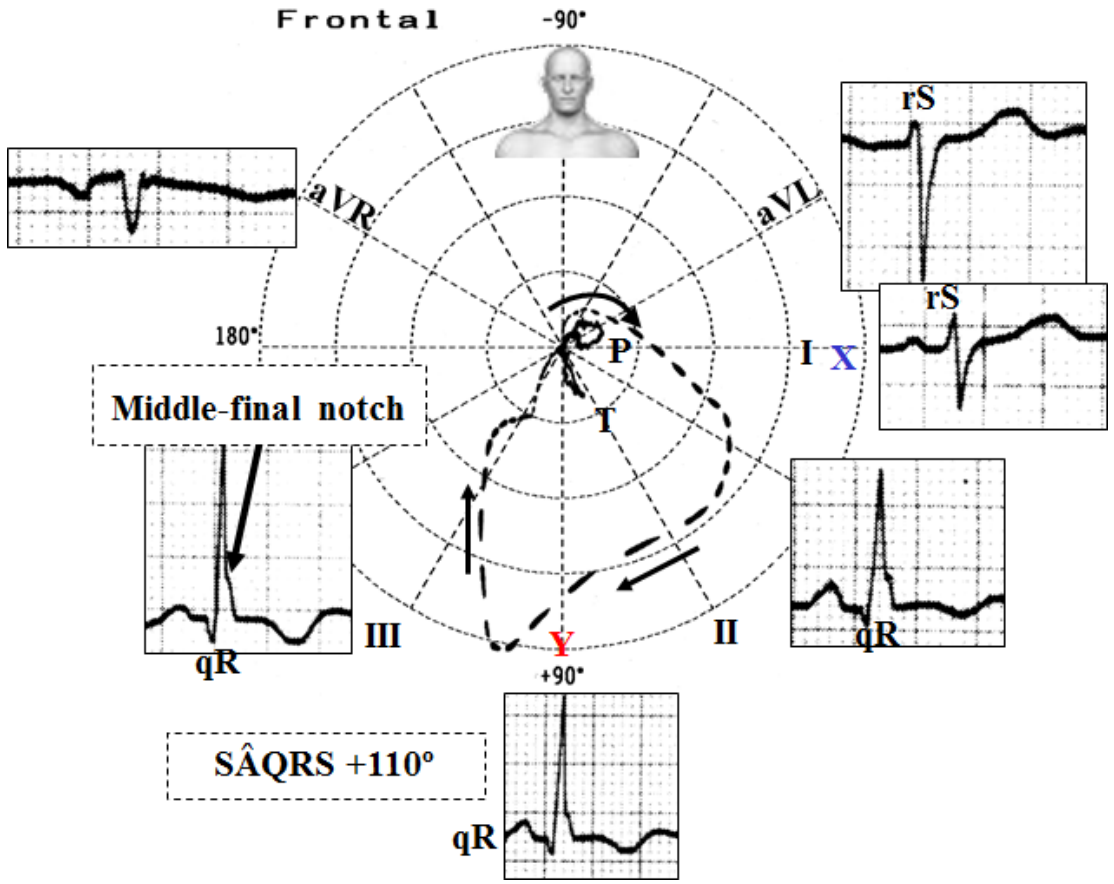
Sinus rhythm, heart rate 71 bpm, QRS axis +120°; QRS duration ≈160 ms; PR interval 180 ms; rS pattern in leads I and aVL; qR pattern in III, aVF and II: qIII > qII; Slurring in the descending limb of the R wave in III, II and aVF (middle-final slur); RIII > RII; The q wave in III is greater than the q wave in II and aVF. If there is association with inferior infarction, the Q wave > 40 ms. Conclusion: LPFB + CRBBB.



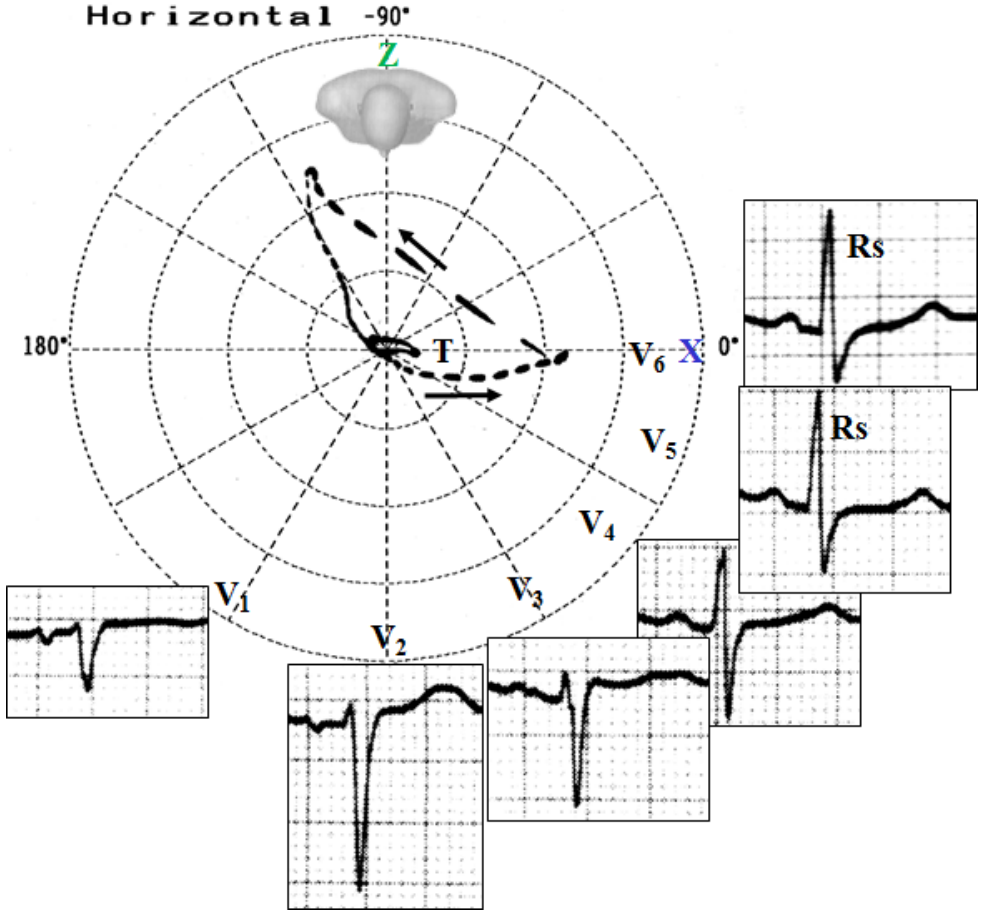
ECG: QRS axis +120°; QRS duration ≈160 ms (80 dashes); PR interval 180 ms; rS pattern in leads I and aVL; qR pattern in III, aVF and II: qIII > qII; Slurring in the descending limb of the R wave in III, II and aVF (middle-final slur); RIII > RII; The q wave in III is greater than the q wave in II and aVF. If there is association with inferior infarction, the Q wave > 40 ms.

Initial 10 to 20 ms vector heading above and to the left (near -30°) with delay (initial 10 to 25 ms); Broad QRS loop, CW rotation; Maximal vector +120º; Almost all the loop is located below the X line in the inferior quadrants; 30% of the loop located in the left inferior quadrant and 70% or more in the right inferior quadrant; Afferent limb heading below and slightly to the left, and the efferent one to the right; Middle-terminal portion of the QRS loop (vector of 60 ms to 100 ms) with delay of 40 ms (RECD); T loop with CW rotation, heading to the left: alteration secondary to ventricular repolarization.

ECG/VCG correlation of isolated LPFB

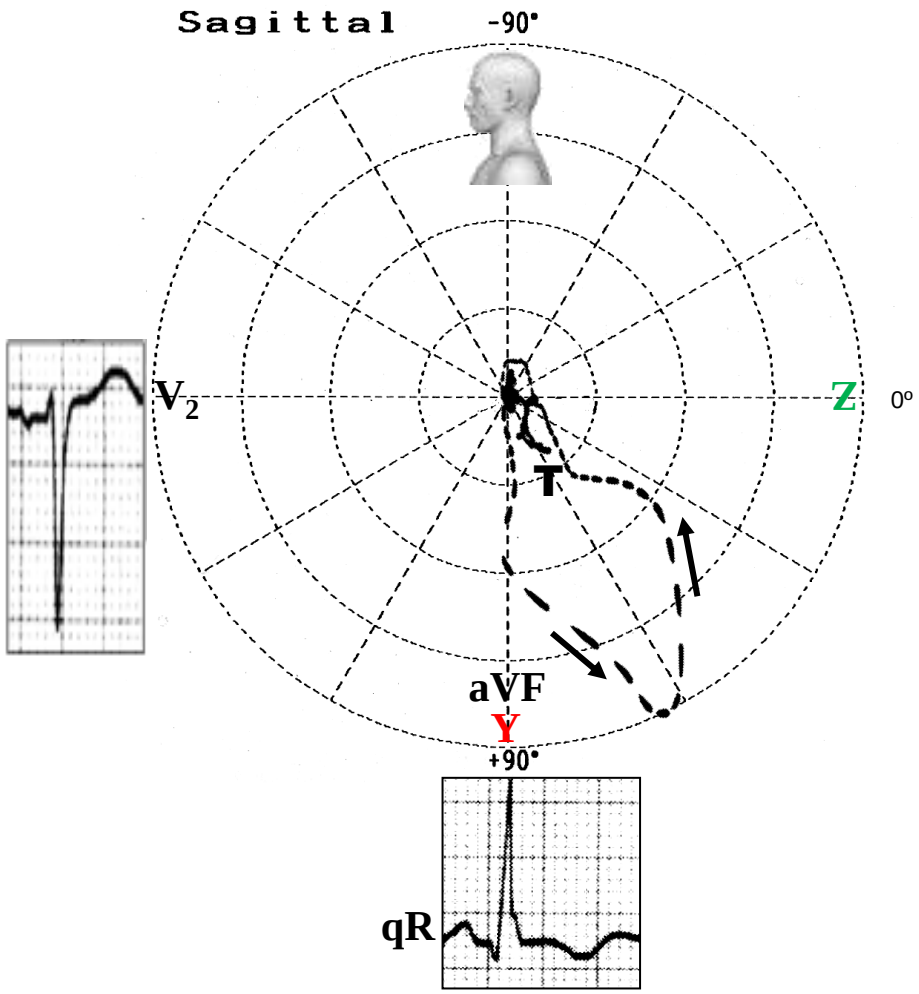


ECG/VCG correlation in the frontal plane of a typical case of LPFB: vector of initial 10 to 20 ms heading upward and to the left; rS pattern in I and aVL; qR in inferior leads; R in III > R in II; middle final notch in ascending limb of R wave of III; QRS loop of clockwise rotation and broadened morphology in clinical absence of RVH, vertical heart or lateral infarction (the diagnosis of LPFB must obligatorily be clinico-electrocardiographic). Only diagnosis if there is clinical absence of RVH, “vertical heart” or lateral infarction.



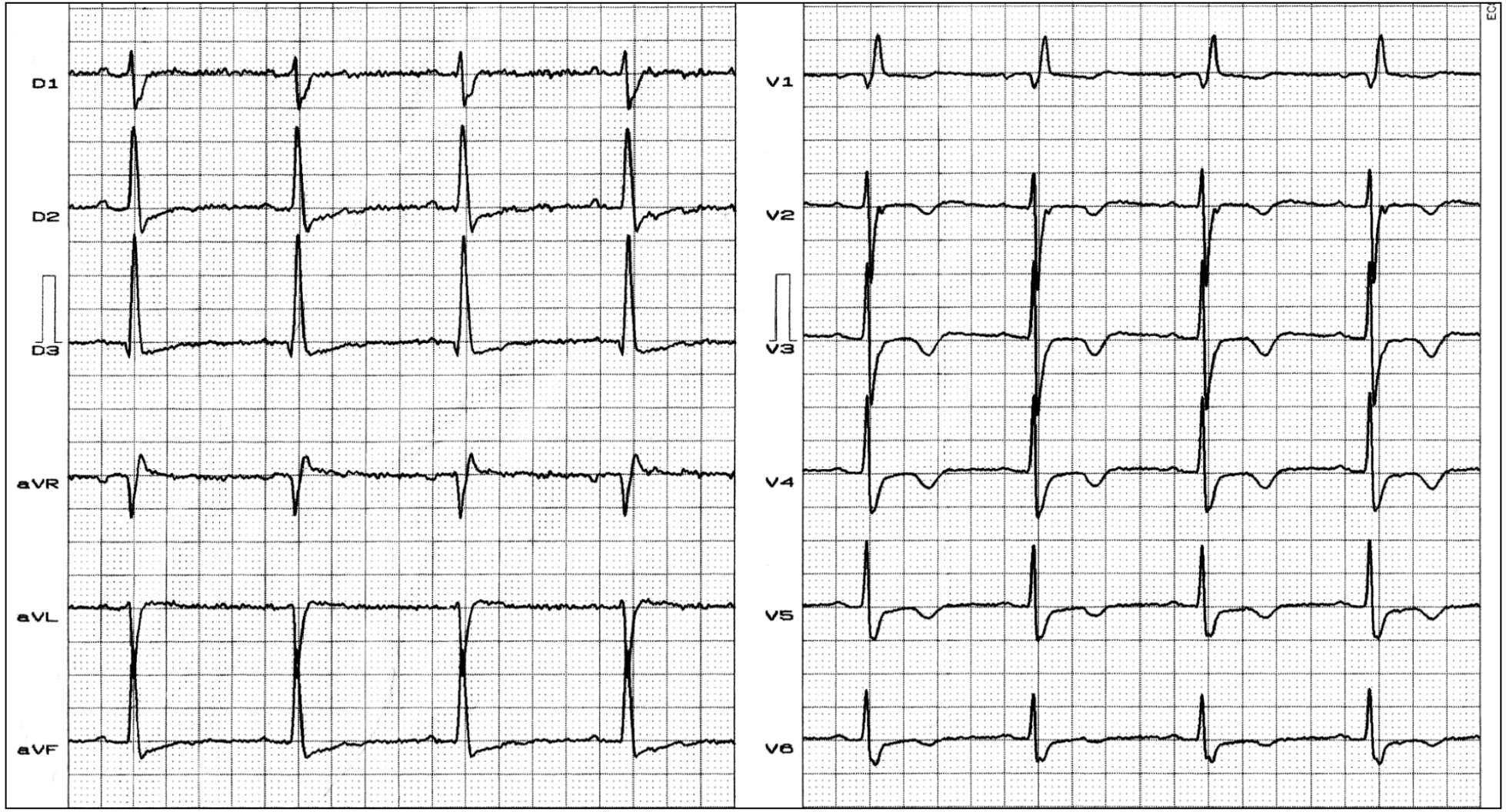
ECG/VCG correlation in the horizontal plane of a typical case of LPFB: vector of initial 10 to 20 ms heading to the front and the left; counterclockwise rotation; > 20% of the area of QRS loop located in the right posterior quadrant; deep S waves in V2 by posterior dislocation of final forces; dislocation to the left of the transition area in precordial leads; RS complexes in V5 and V6.

ECG/VCG correlation in the LSP



ECG/VCG correlation in the left sagittal plane of a typical case of LPFB: QRS loop of counterclockwise rotation and totally located in the postero-inferior quadrant. In aVR a qR pattern is observed, as well as middle final notch in the ascending limb of the R wave. The presence of the initial q wave points out that the vectors of the initial 20 ms are heading above.

Name: GRT **Sex:** Fem. **Age:** 81 y., **Race:** White **Weight:** 64Kg **Height:** 1.63 m **Date:** 04/03/2004 **Medication in use:** Isosorbide + Digoxin 0.25 mg + Enalapril 10 mg 2X + Atenolol 50 mg +ASA 200 mg



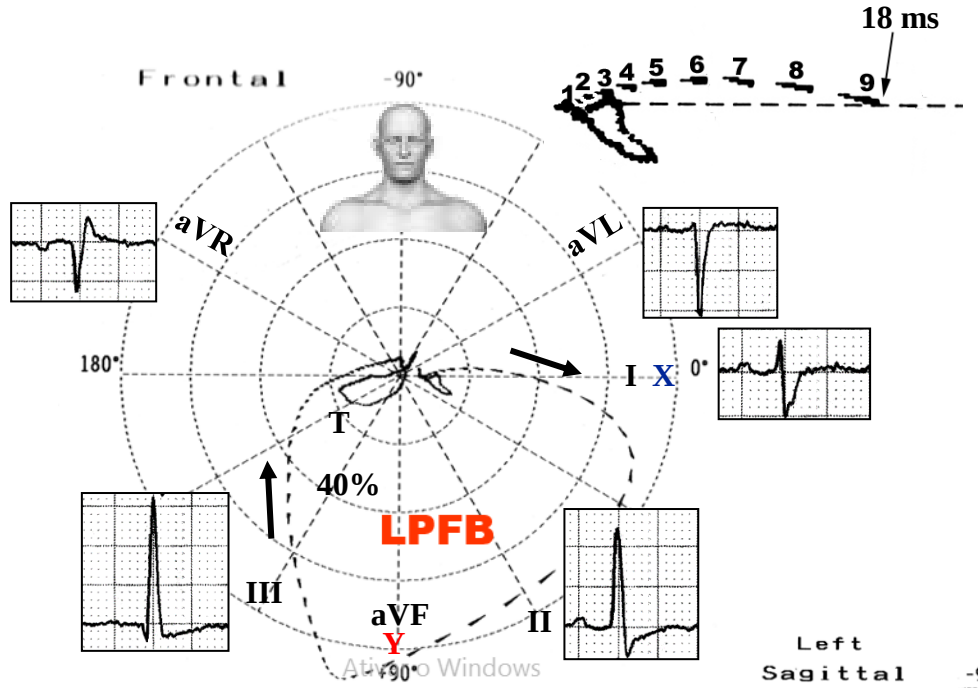
Clinical diagnosis: ECG of a male patient, carrier of hypertensive and ischemic cardiomyopathy that shows left bifascicular block formed by: CRBBB + LPFB. Inferior subepicardial ischemia (symmetrical and inverted T waves from V2 to V6) and qR pattern in V1 are observed.

ECG diagnosis: SAQRS: $+115^{0}$; QRS duration: 140 ms; DI and aVL= rS; DIII= qR; RIII > RII; qR in V1; final broad S wave in left leads; inverted and symmetrical T wave in precordial leads;

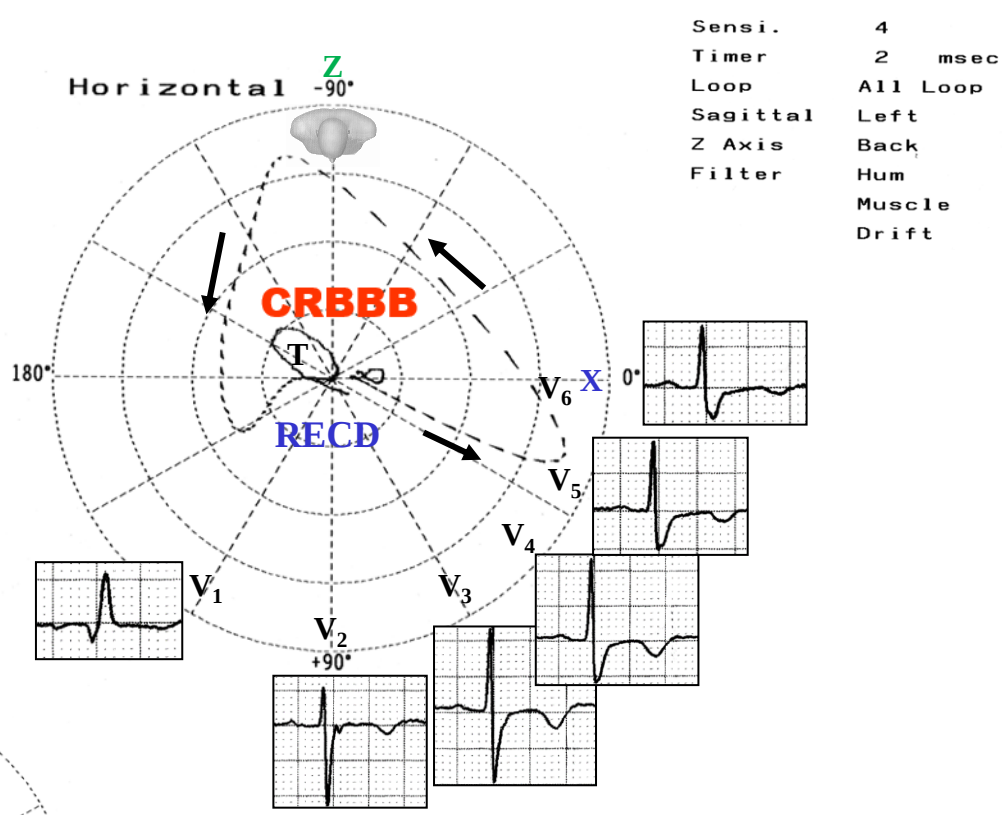
CONCLUSION: 1) CRBBB; 2) LPFB: Left Bifascicular Block; 3) Anterior subepicardial ischemia.

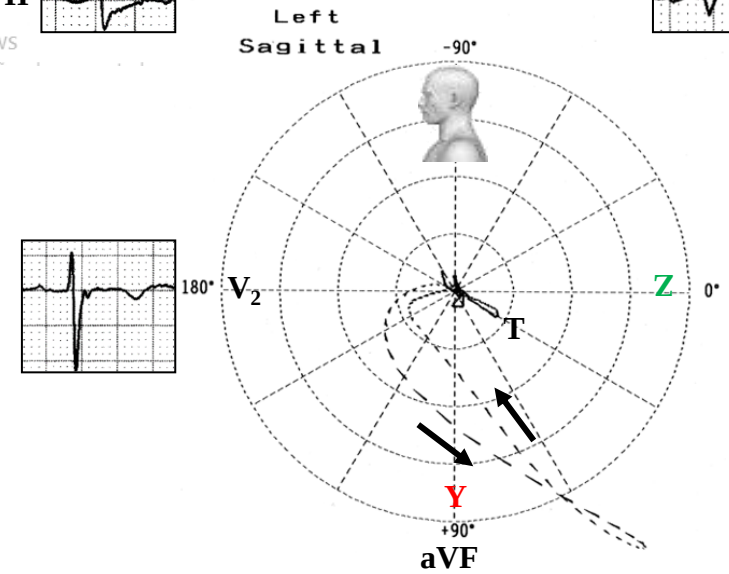
Note: ectomorphic vertical heart, RVH and lateral wall infarction were clinically ruled out.

ECG/VCG correlation of LPFB + CRBBB



ECG/VCG correlation in the frontal plane where the following stands out: rS in I and aVL; qR in III; voltage of R wave of III >15 mm and > R wave of II; vector of initial 18 ms above the X line; QRS loop of CW rotation; aspect of "fat" QRS loop; ≥ 40% of the QRS loop located to the right: LPFB associated to CRBBB.





ECG/VCG correlation in the HP where the following stand out: qR pattern in V1 (it may be observed in CRBBB associated to LPFB even in absence of septal infarction); "broad" S wave of left leads: CRBBB; right end conduction delay in "glove finger" located in the right anterior quadrant: CRBBB; afferent limb of the QRS loop located behind the orthogonal X lead: CRBBB of the VCG Grishman type or Kennedy type I.

LPFB differential diagnosis

Obligatorily, the diagnosis of LPFB must be clinical-electro-vectorcardiographic. The diagnosis is not possible in the presence of:

I. A vertical heart in slender subjects (ectomorphic biotype);

II. Presence of any cause for right ventricular hypertrophy/RVE, especially COPD/emphysema: frequent right atrial enlargement;

III. A large myocardial infarction of lateral wall: QS in I and aVL **(1)**;

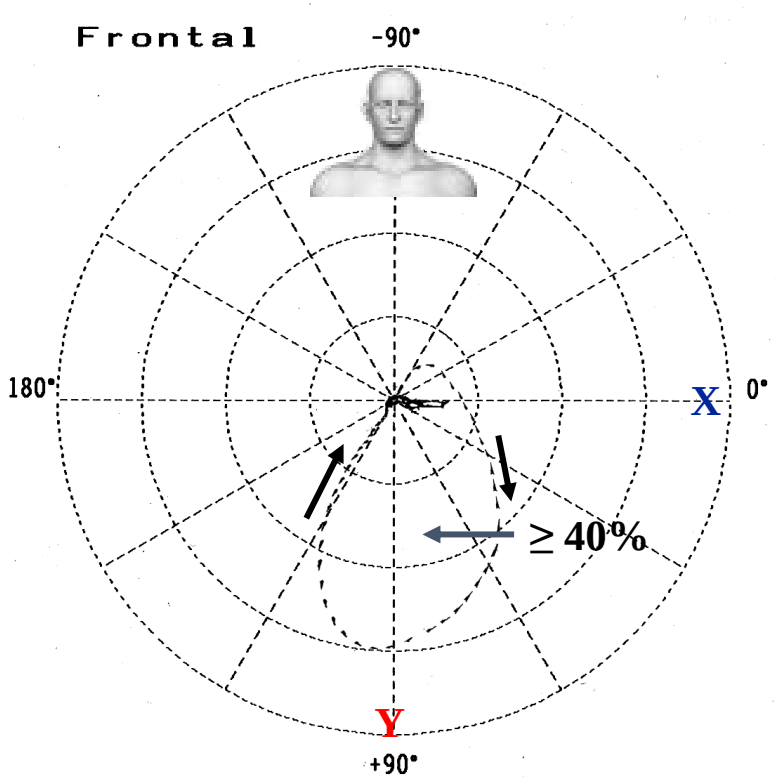
IV. Right End Conduction Delay (RECD) by the inferior fascicle of the right bundle branch or RECD type II of our classification.

V. Hereditary right axis deviation with pseudo left posterior fascicular block and incomplete right bundle branch block **(2)**

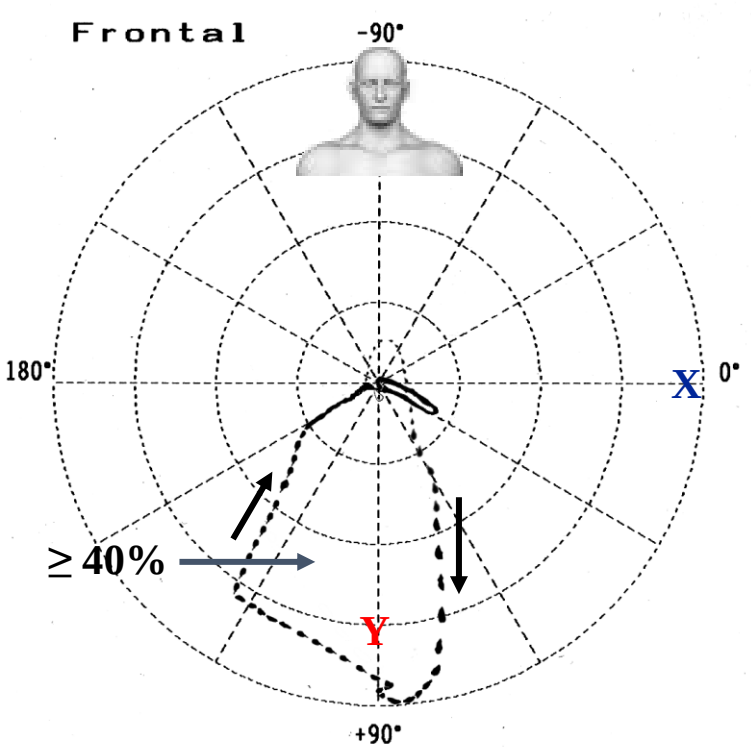
1. **Marcelo V Elizari 1, Rafael S Acunzo, Marcela Ferreiro. Hemiblocks revisited. Circulation. 2007 Mar 6;115(9):1154-63. doi: 10.1161/CIRCULATIONAHA.106.637389.**
2. **A Lorber 1, E Maisuls, J Naschitz. Hereditary right axis deviation: electrocardiographic pattern of pseudo left posterior hemiblock and incomplete right bundle branch block. Int J Cardiol. 1988 Sep;20(3):399-402. doi: 10.1016/0167-5273(88)90295-1.**

Differences in the FP between isolated LPFB and in association to CRBBB

	Isolated LPFB	LPFB + CRBBB
QRS duration:	90 to 110 ms	≥120 ms
Location of QRS loop	≥ 40% left of Y line	≥ 40% to the right of the Y line
Vector of final 20 ms	There might be delay, but discrete.	With important delay to the right.



45 to 50 dashes in QRS loop: 1 dash = 2 ms

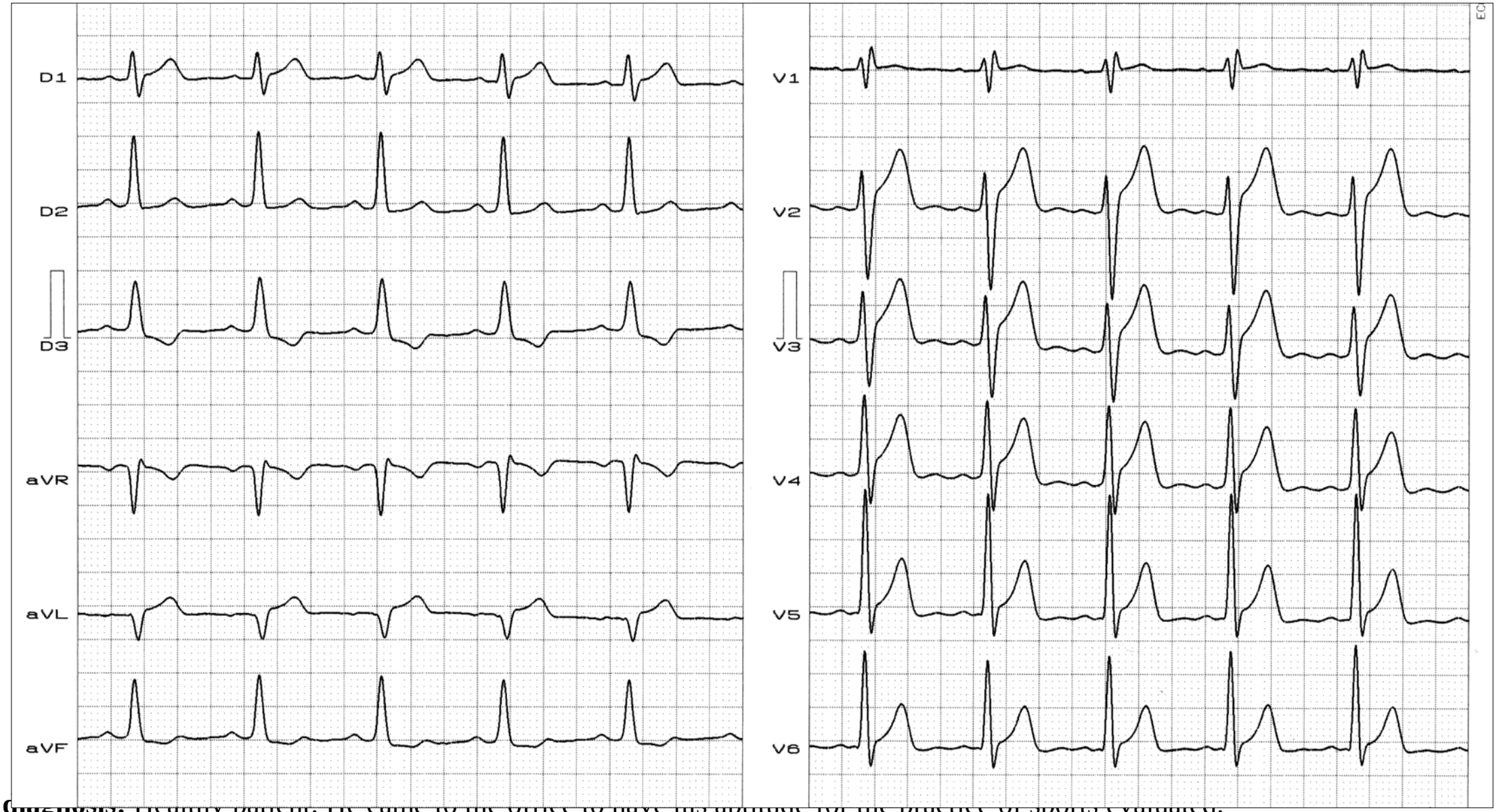


≥ 60 dashes in QRS loop: 1 dash = 2 ms

Differential diagnosis between Right End Conduction Delay type II and Left Posterior Fascicular Block (LPFB)

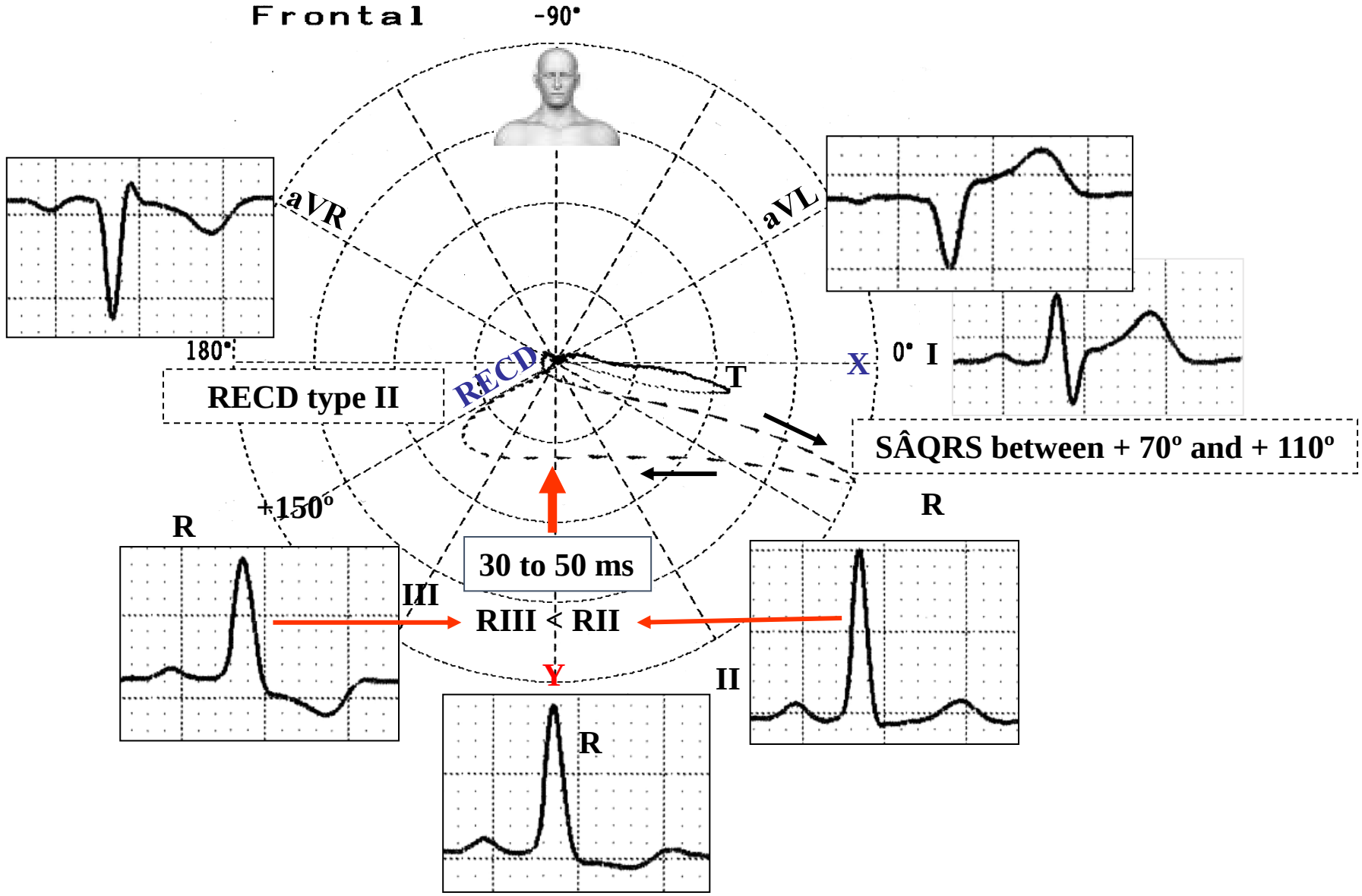
	RECD type II or Right Posterior Subdivision Block	LPFB
PR interval	Normal.	Frequent prolongation.
Association with inferior infarction	No.	Frequent.
Voltage of RII and RIII	≤ 10 mm.	≥ 15 mm.
RII/RIII voltage ratio	RII >RIII.	RIII > RII.
Notch in the descending ramp of R wave of inferior leads	Absent.	Constant middle-final notch.
Ventricular activation time in aVF, V5 and V6	Normal.	Increased: up to 30 ms.
Ventricular activation time in aVL	Normal.	Decreased: up to 15 ms.
QRS loop in the FP	Clockwise rotation and with characteristic rapid passage from left to right between 30 and 50 ms. RECD on inferior right quadrant.	Clockwise, aspect of “fat” loop and maximal vector close to + 120°.

Name: BMB; **Sex:** M; **Age:** 20 yo; **Race:** White; **Weight:** 78 Kg; **Height:** 1.81 m; **Biotype:** Athletic;
Date: 18/09/2004; **Medication in use:** nothing stated

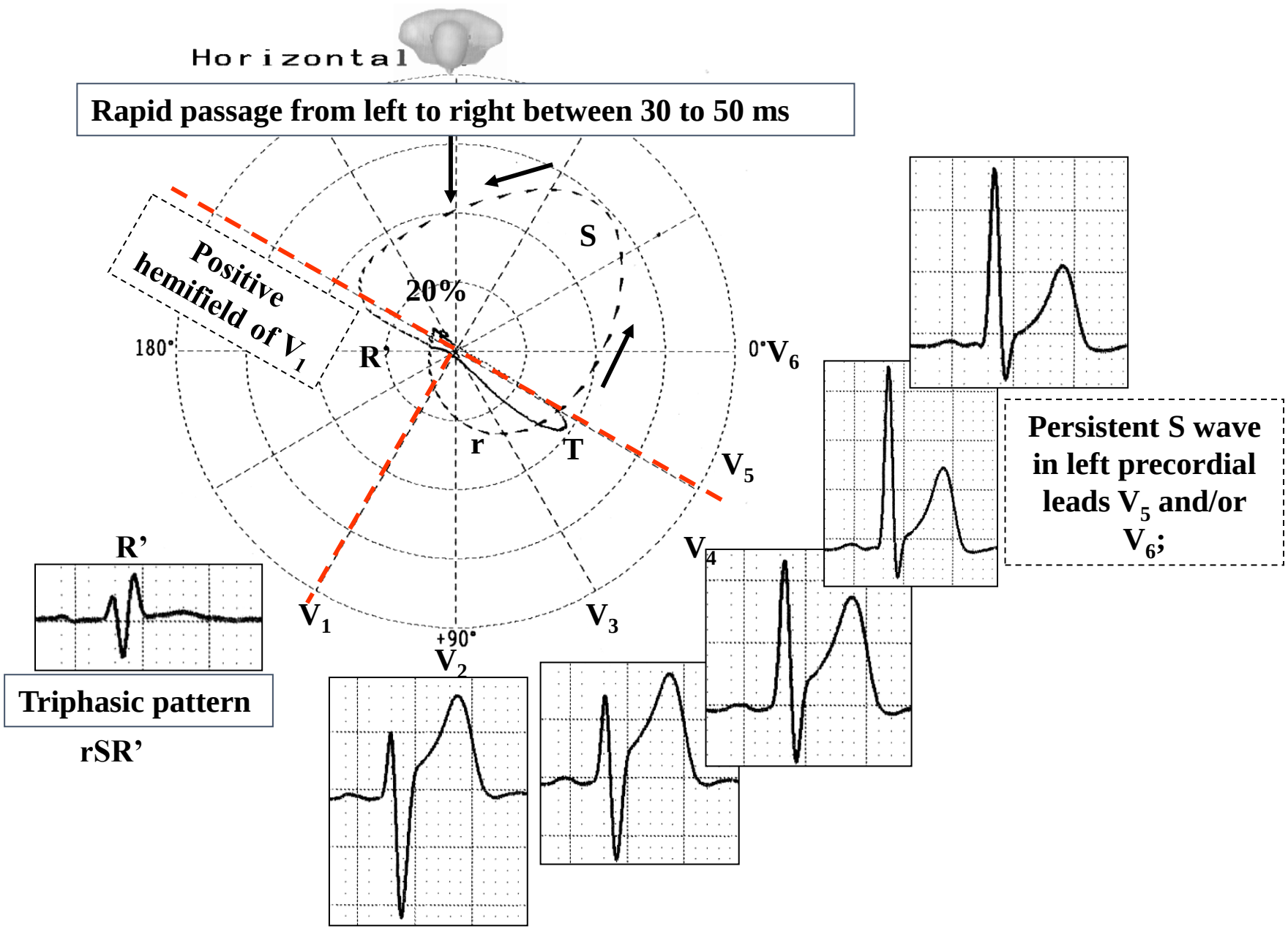


Clinical diagnosis: Healthy patient. He came to the office to have his aptitude for the practice of sports evaluated.
ECG diagnosis: SÂQRS: + 85º. RII > RIII. SAT: + 5º to the front and the left. Morphology of IRBBB: rSR' in V1.
Conclusion: ECG of RECD type II. Why? Because patterns are observed on next slide.

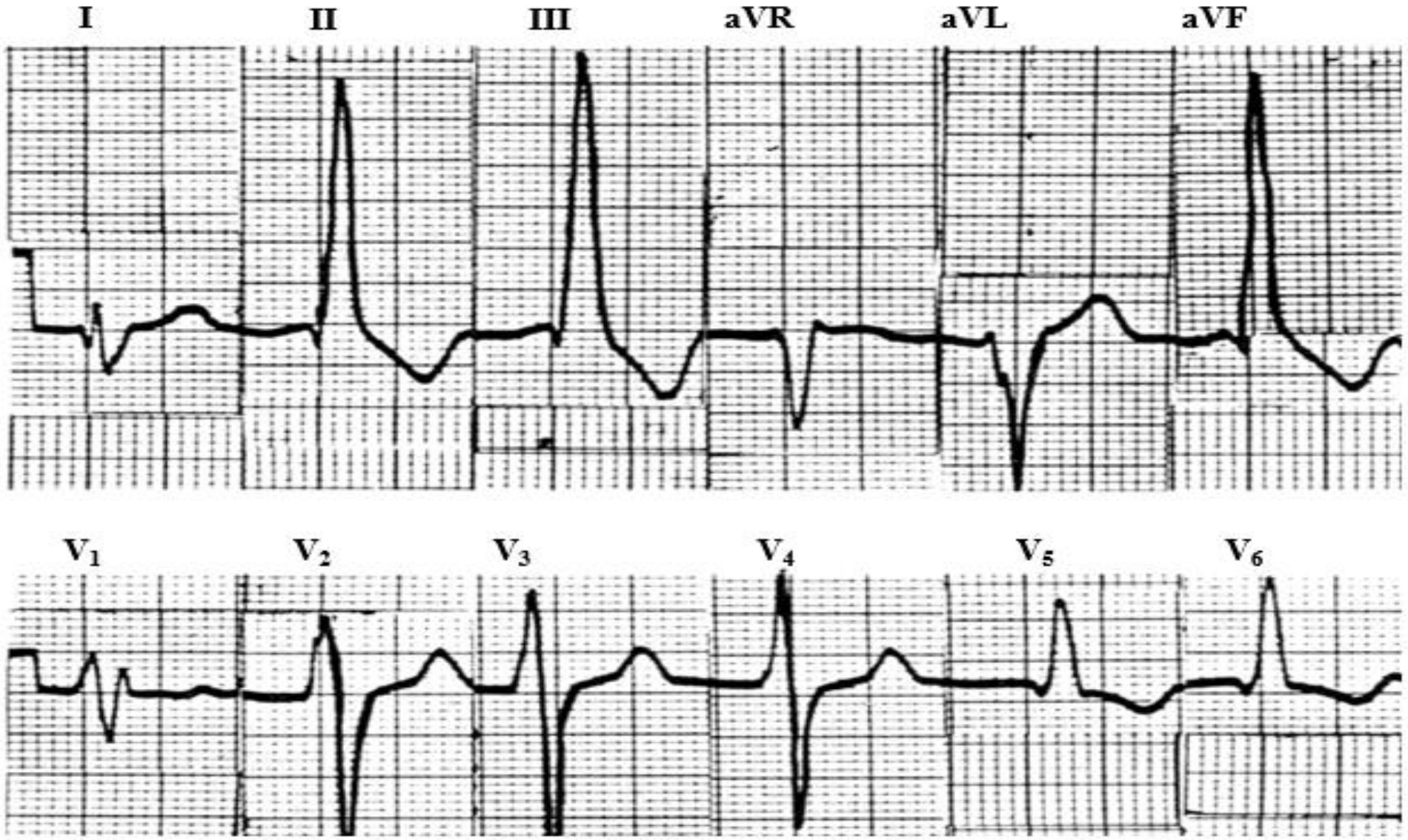
ECG/VCG correlation on Frontal Plane



QRS loop located on inferior quadrants with CW rotation, rapid passage from left to right between 30 to 50 ms and RECD located on inferior right quadrant



ECG/VCG correlation in horizontal plane of ECD type II.



SÂQRS +110º, qR pattern in III, II and aVF, RIII = 30 mm > RII, in V_1 deep rSr' with QRSd > 120 ms, deep S wave in V_2-V_3, and strain pattern of repolarization in V_5 and V_6.

Conclusion: CRBBB + LPFB + LVH

MY HEART

Córdoba is a city located near the geographical center of Argentina, in the foothills of the Sierras Chicas on the Suquía River, about 700 km northwest of Buenos Aires. It is the capital of Córdoba Province. Córdoba is the second-largest city in Argentina after the federal capital Buenos Aires, with about 1.5 million inhabitants. The National University of Córdoba, (UNC), is the oldest university in Argentina, and one of the oldest in the Americas. Since the early 20th century it has been the second largest university in the country (after the University of Buenos Aires) in terms of the number of students, faculty, and academic programs. As the location of the first university founded in the land that is now Argentina, Córdoba has earned the nickname *La Docta* (roughly translated, "The Wise").

São Paulo is the largest city in Brazil, the largest city in the western and southern hemispheres, and the world's eighth largest city by population. The metropolis is anchor to the São Paulo metropolitan area, ranked as the second-most populous metropolitan area in the Americas and among the five-largest metropolitan areas on the planet. São Paulo is the capital of the state of São Paulo, the most populous Brazilian state and exerts strong regional influence in commerce and finance as well as arts and entertainment. São Paulo maintains strong international influence and is considered an Alpha – World City. The name of the city honors Saint Paul.