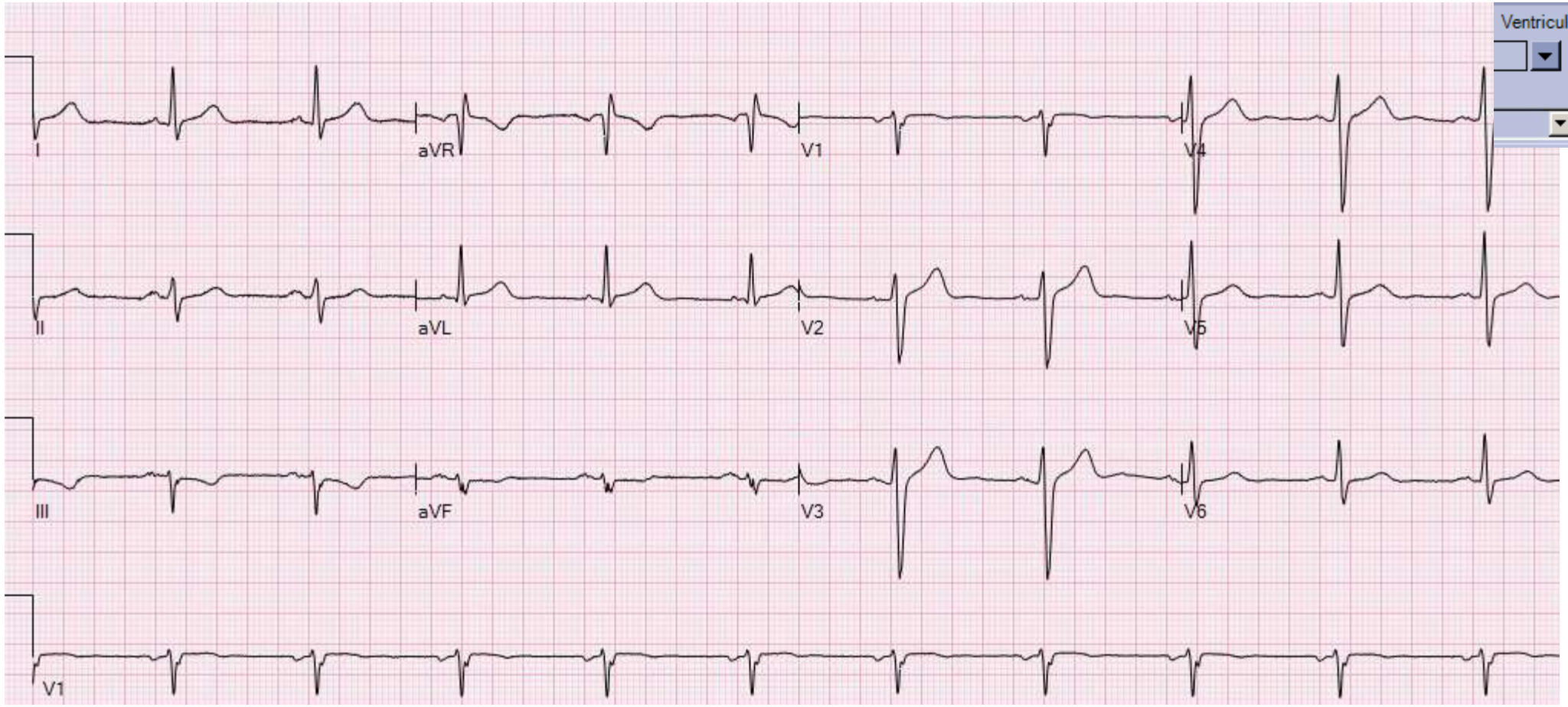
59-year old man Caucasian (Finnish)

Hypertension, dyslipidemia

Intermittent palpitations since many years

Positive heredity for coronary artery disease

ECG: possibly LAFB and partial RBBB



Ventricular, atrial rate:	63	63	bpm
PR, QRS:	154	112	ms
QT, QTc:	420	429	ms
PRT Axis:	49	-32	-1 °

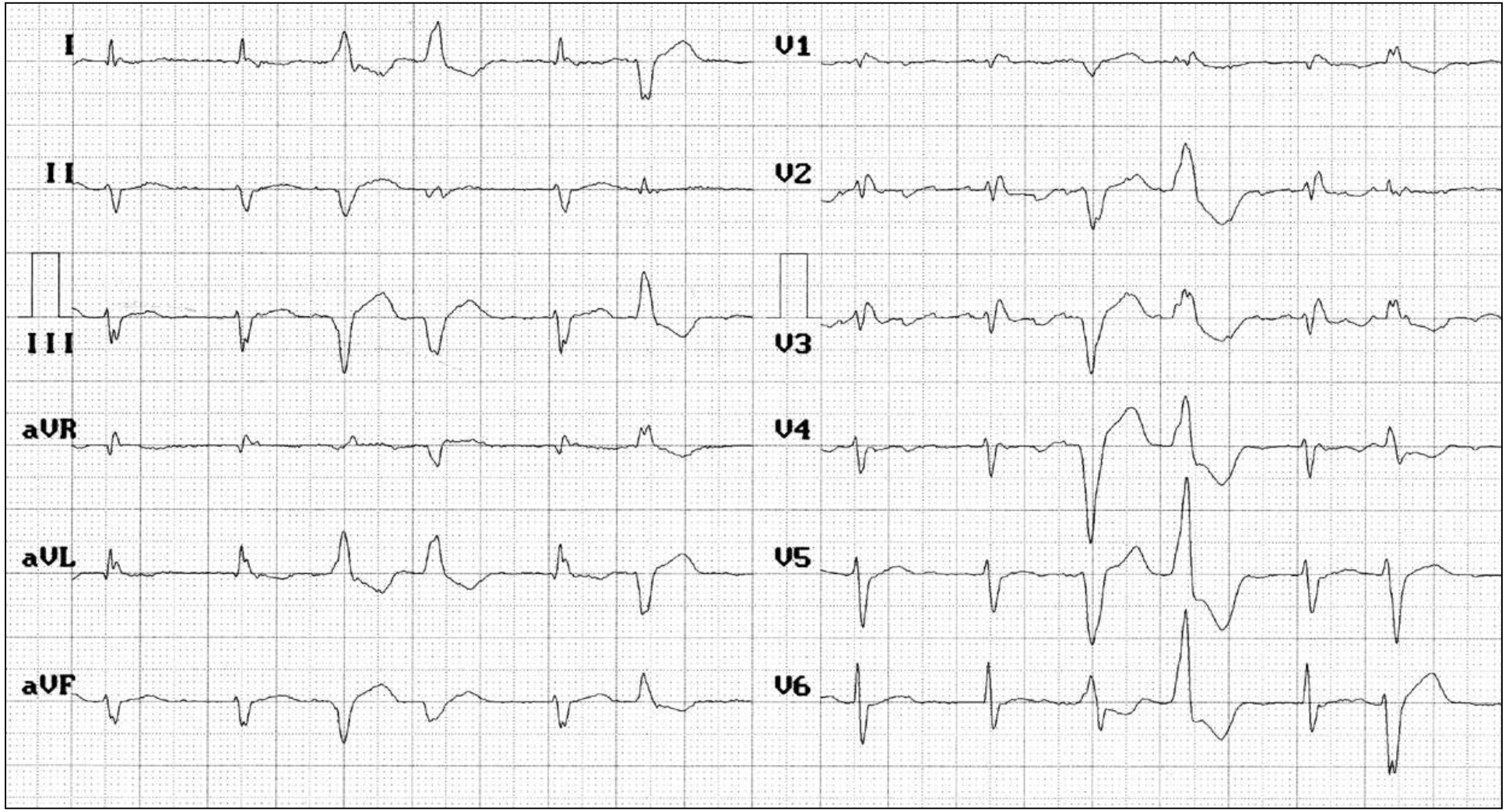
Incomplete RBBB is very rare in Chronic chagasic cardiomyoppathy

Electrocardiogram The ECG is the single most important test in the initial evaluation of patients with definite or suspected Chagas disease. In those who come from endemic regions but without known infection, the existence of typical ECG bnormalities on the ECG may raise the clinical suspicion, and it is an additional reason to order a serological test. In patients with a **confirmed serological diagnosis** of chronic Chagas disease, the ECG can recognize those with established cardiomyopathy, in whom typical ECG findings will occur or, if normal, can point to the presence of the indeterminate chronic form, which should be confirmed by the absence of clinical manifestations and normal radiological tests (at least a chest x-ray). The presence of some ECG abnormalities, such as atrioventricular blocks and AF, demands immediate treatment, and a higher number of major ECG abnormalities is related to a higher risk of death. The ECG should be repeated on a regular basis because the appearance of an electrocardiographic abnormality even in those with a previous abnormal ECG is frequently recognized as a marker of the progression to cardiomyopathy, which results in the need for further testing and evaluation. For those with symptoms of cardiac arrhythmias, such as palpitations, syncope, and aborted sudden death, a resting ECG is obligatory before further testing with Holter monitoring, stress testing, or electrophysiologic study. Unlike individuals with premature ventricular contractions detected on the 12-lead ECG who have no structural cardiac disease and have an entirely benign prognosis, patients with Chagas disease in whom premature ventricular contractions are found on the ECG carry a very high risk of having complex ventricular arrhythmia, and Holter monitoring is mandatory in this clinical setting.

Electrocardiographic elements of poor prognosis in chronic chagasic myocarditis

- Presence of atrial fibrillation or flutter;
- Presence of CLBBB (rare) in 91.3% of the cases and decreased ejection fraction;
- Presence of total AV block;
- Presence of anterior and inferior electrically inactive area;
- Presence of polymorphic premature ventricular contractions or in salvoes;
- Presence of NS-VT associated to decreased EF: 80% of mortality in 13 years of follow-up. When the EF is normal, the prognosis is good;
- Presence of S-VT: 100% of mortality in five years.

Typical ECG of chronic chagasic heart disease



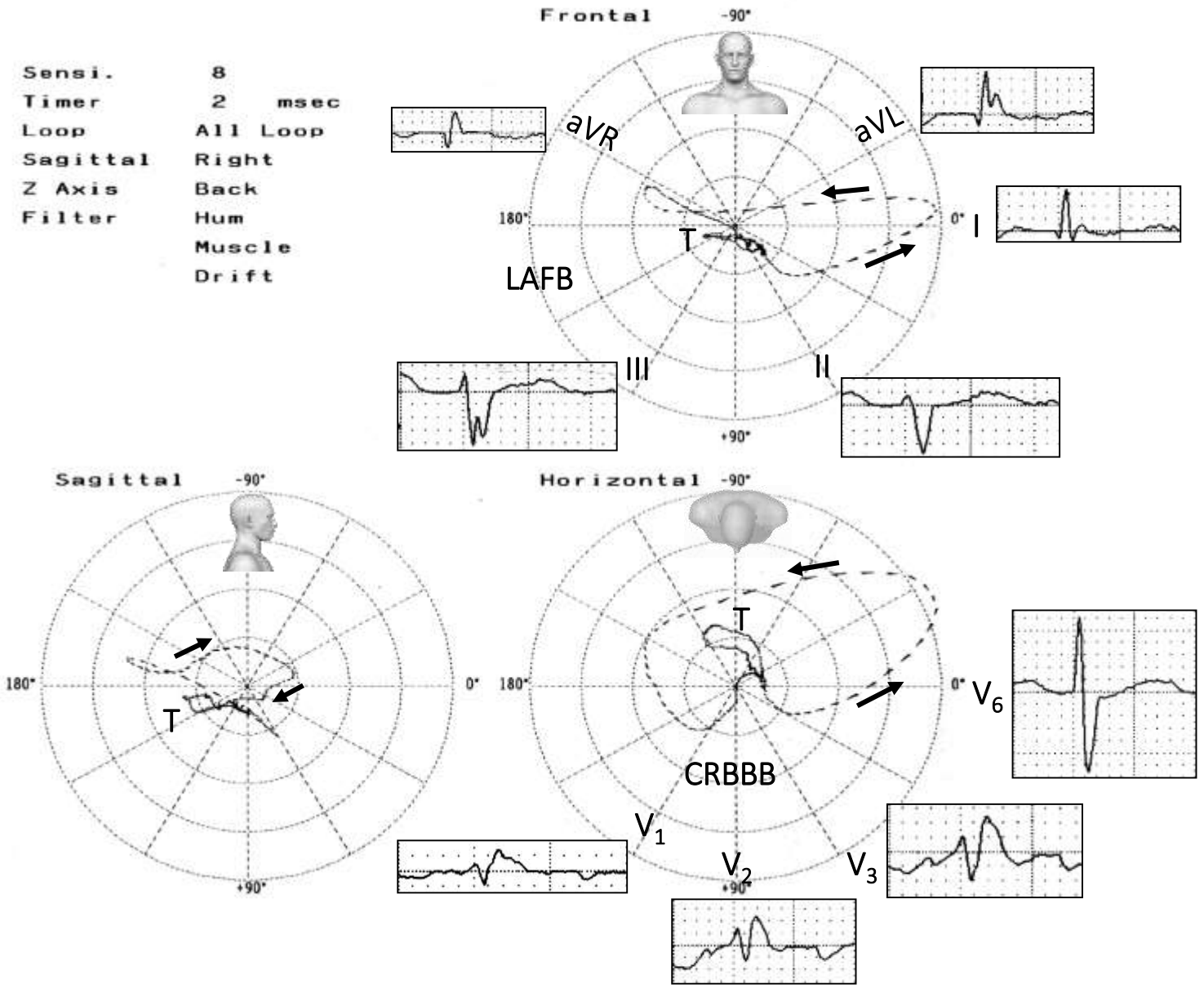
P wave difficult to visualize, which indicates intense fibrosis of atrial tissue.

LAFB: extreme shift of ÂQRS in the left superior quadrant, around –75º, qR in I and aVL, rS in inferior leads with S wave in V_5 and V_6

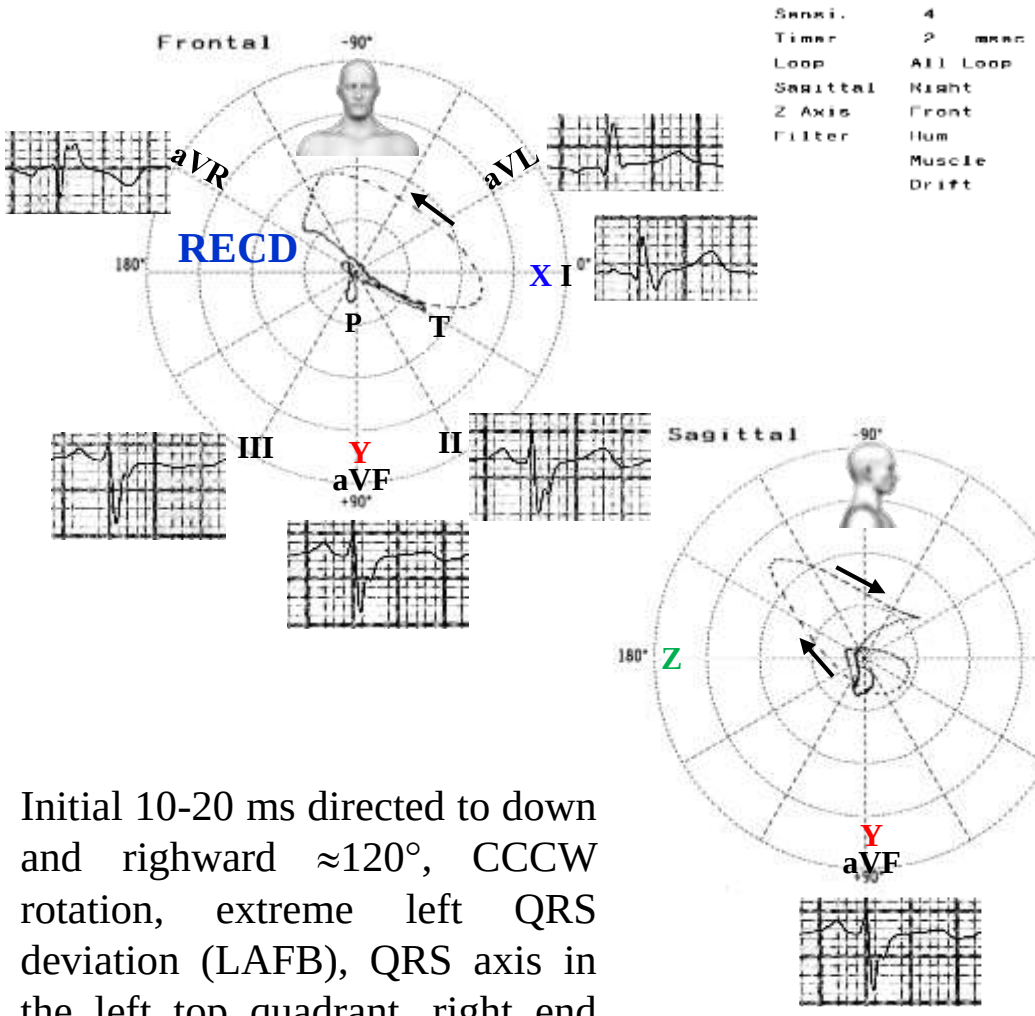
CRBBB: triphasic complex, rsr' type, from V_1 to V_3, broad r wave in aVR and S wave in V_5 and V_6. Coupled polymorphic premature ventricular contractions.

Classical triad: CRBBB + LAFB + polymorphic premature ventricular contractions.

ECG/VCG correlation of typical chronic chagasic cardiomyopathy: CRBBB + LAFB + polymorphic premature ventricular contractions

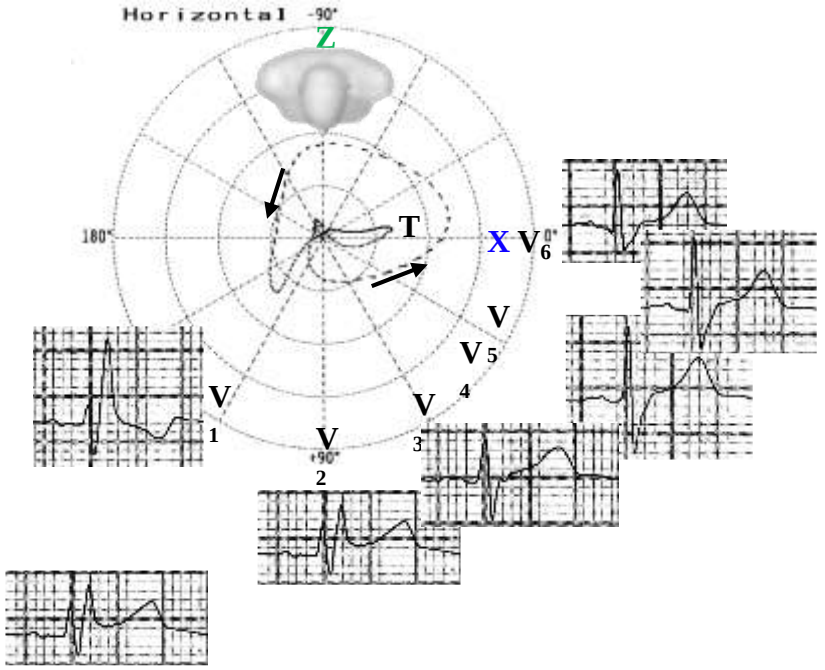


ECG/VCG correlation typical pattern in Chagasic Cardiomyopathy: RBBB Grishman type + LAFB



Initial 10-20 ms directed to down and righward ≈120°, CCCW rotation, extreme left QRS deviation (LAFB), QRS axis in the left top quadrant, right end conduction delay (**RECD**) in the top right quadrant (RBBB).

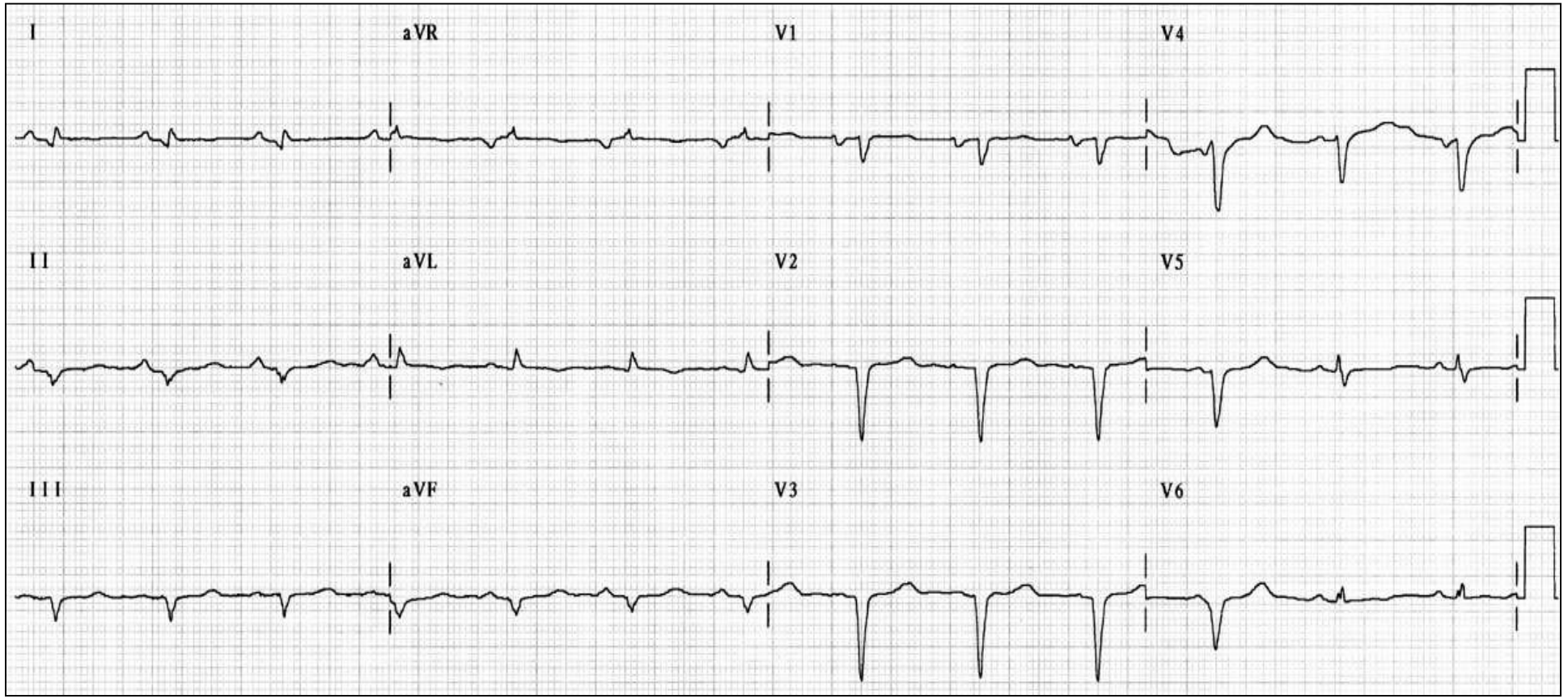
Complete RBBB Grishman type



Initial 10 ms vector directed to front and righward, efferent limb located to front X orthogonal lead, CCW rotation, afferent limb behind X orthogonal lead, **RECD** in the anterior right quadrant with slow inscription, QRS loop duration ≥120 ms
T-loop directed to left and backward with CW rotation.

ECG/VCG of a typical case of chagasic cardiomyopathy

Name: LRS; **Sex:** F; **Age:** 24 y/o; **Ethnic group:** Afro-descendant; **Weight:** 54 Kg; **Height:** 1.68 m; **Biotype:** Normal **Date:** 09/09/2003; **Medication in use:** digoxin 0.25 mg 1x; enalapril 10 mg 2x; spironolactone 25 mg 1x; amiodarone 200 mg 1x; carvedilol; ASA 100 mg 2x.

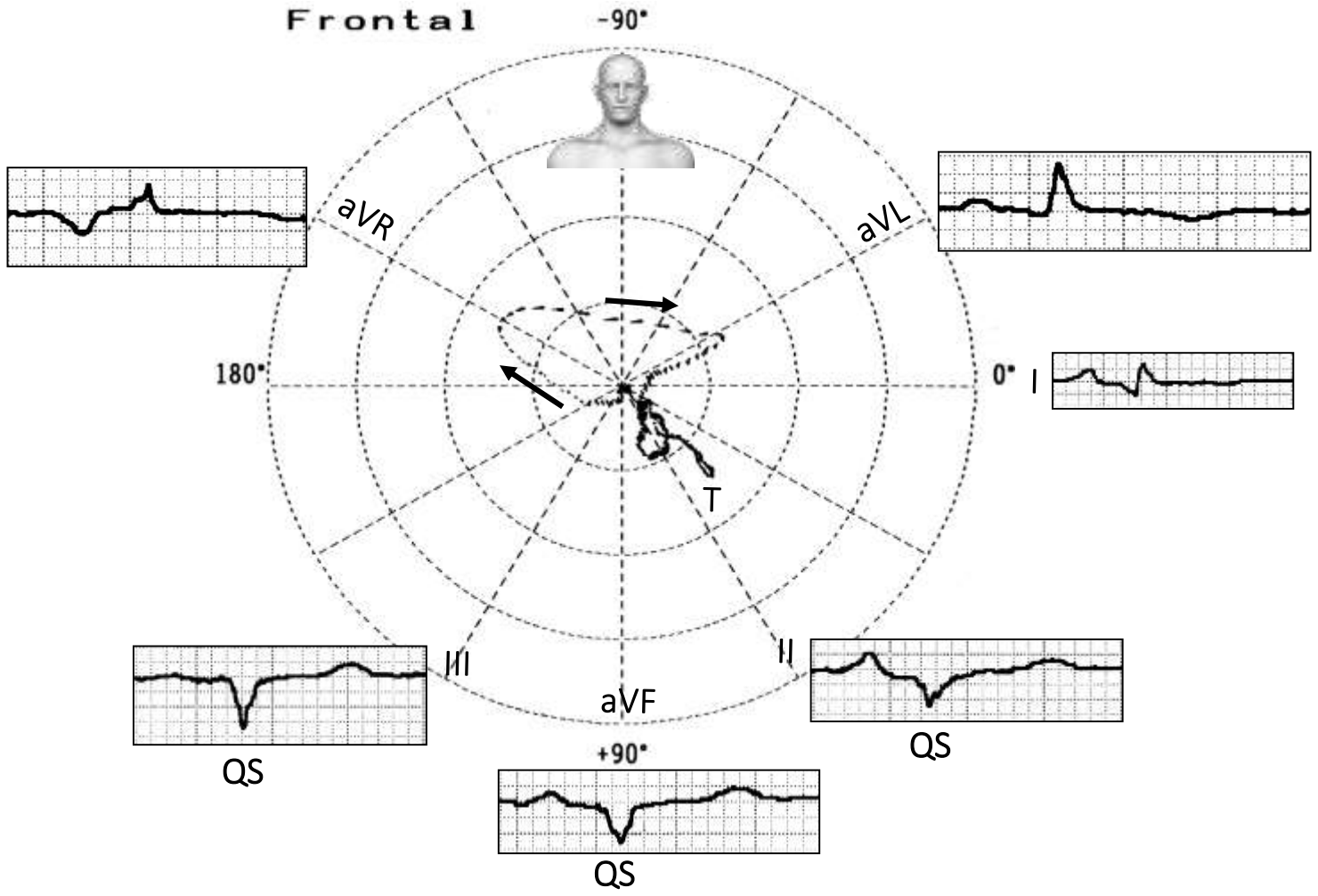


Clinical diagnosis: Chronic Chagasic Cardiomyopathy, Mixed Form with Arrhythmia and CHF.

ECG diagnosis: SR; HR: 76 bpm; P wave: SAP +40º forward; slow final negative component in V1: LAE; PR interval: 183 ms; QRS: SÂQRS: -70º: extreme backward shift in the left superior quadrant and 92 ms duration. QS: II, II and aVF: inferior electrically inactive area. QS from V1 to V3: anterior electrically inactive area. QTc interval: 470 ms (prolonged for heart rate).

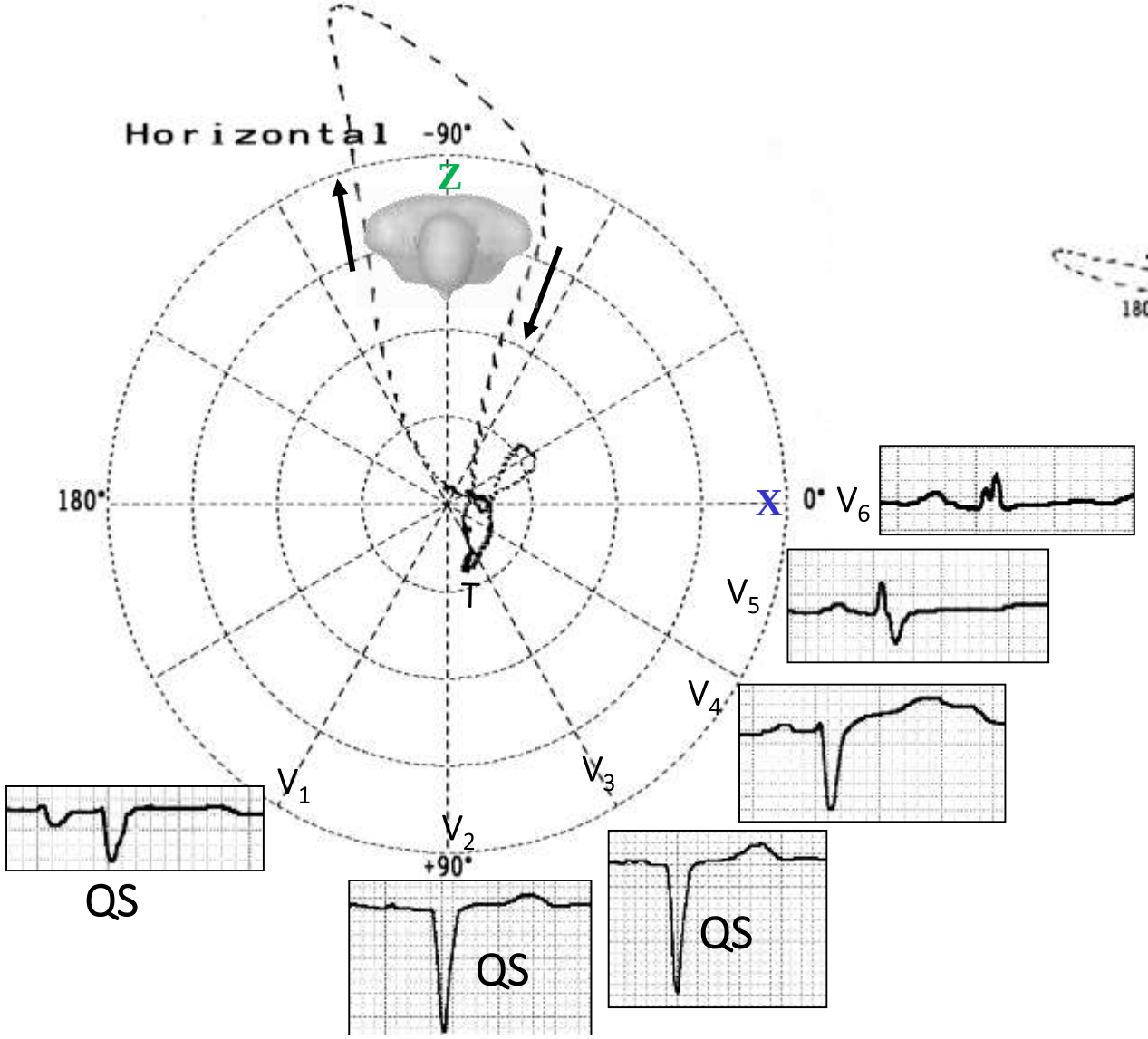
Conclusion: LAE + anterior, inferior, and anteroapical electrically inactive area. Prolonged QT interval.

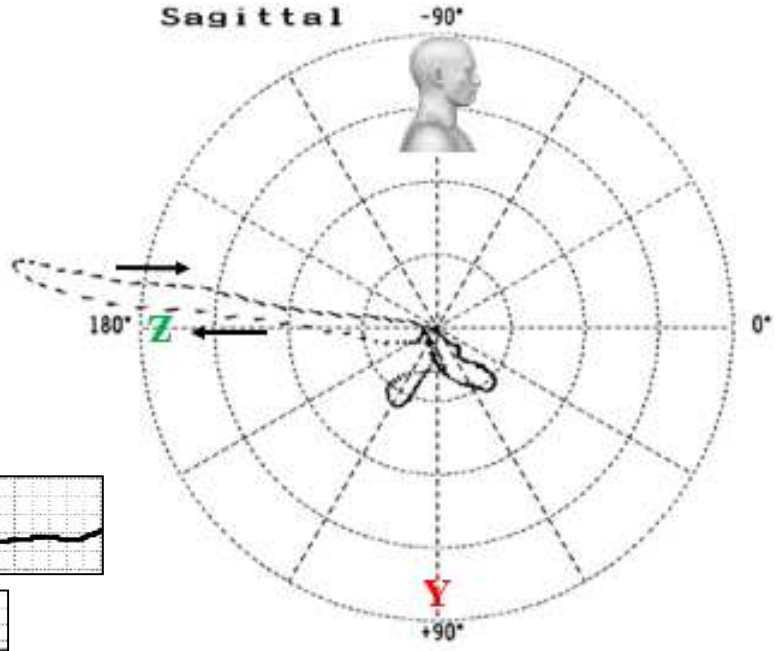
ECG/VCG correlation in the frontal plane



Inferior electrically inactive area. QRS loop of clockwise rotation, superior shift and with initial and final delay. Low voltage r wave indicating high lateral extension. Probable high lateral extension.

ECG/VCG correlation in the horizontal and right sagittal planes

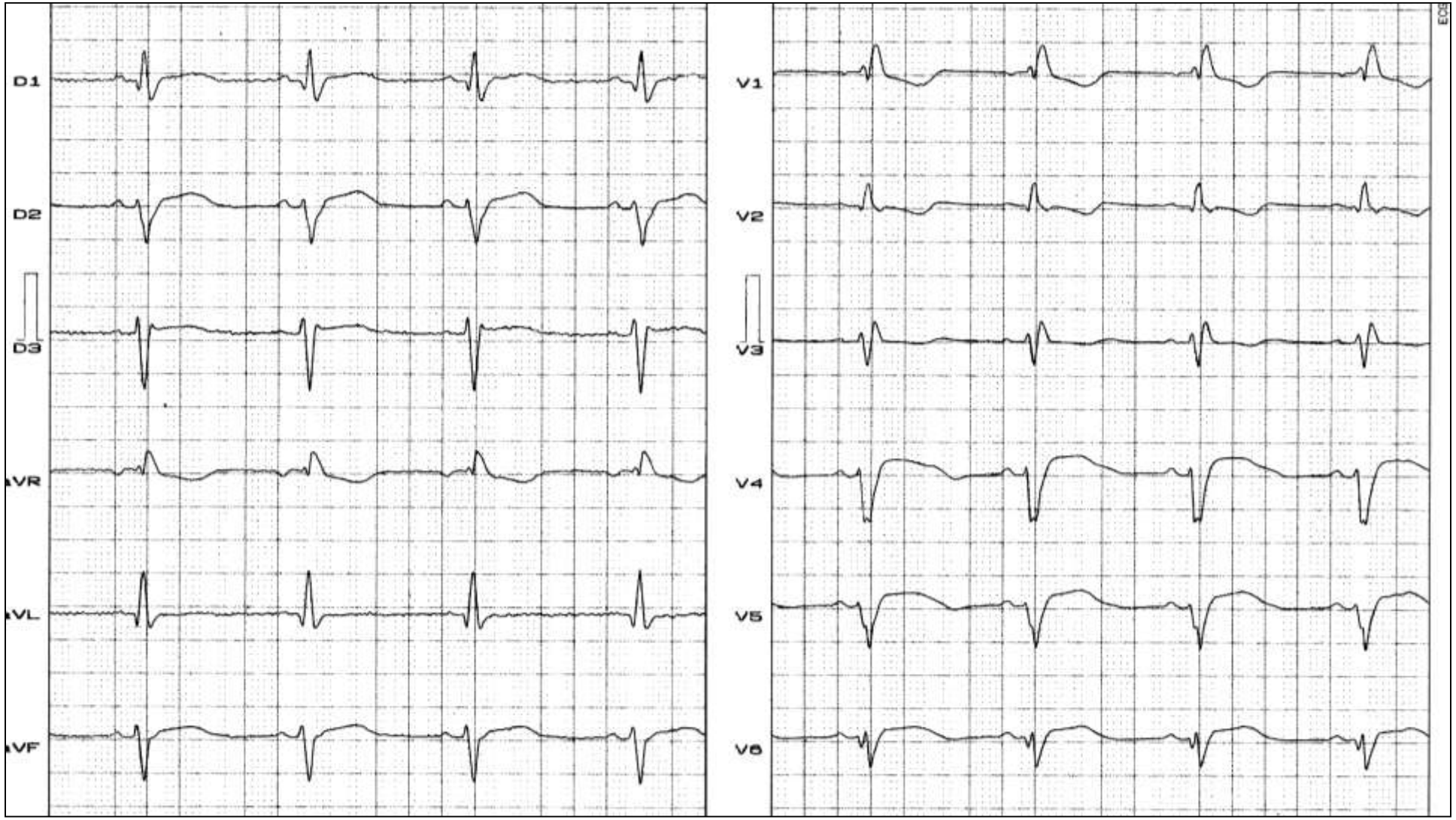




Sensi.	8
Timer	2 msec
Loop	All Loop
Sagittal	Right
Z Axis	Back
Filter	Hum
	Muscle
	Drift

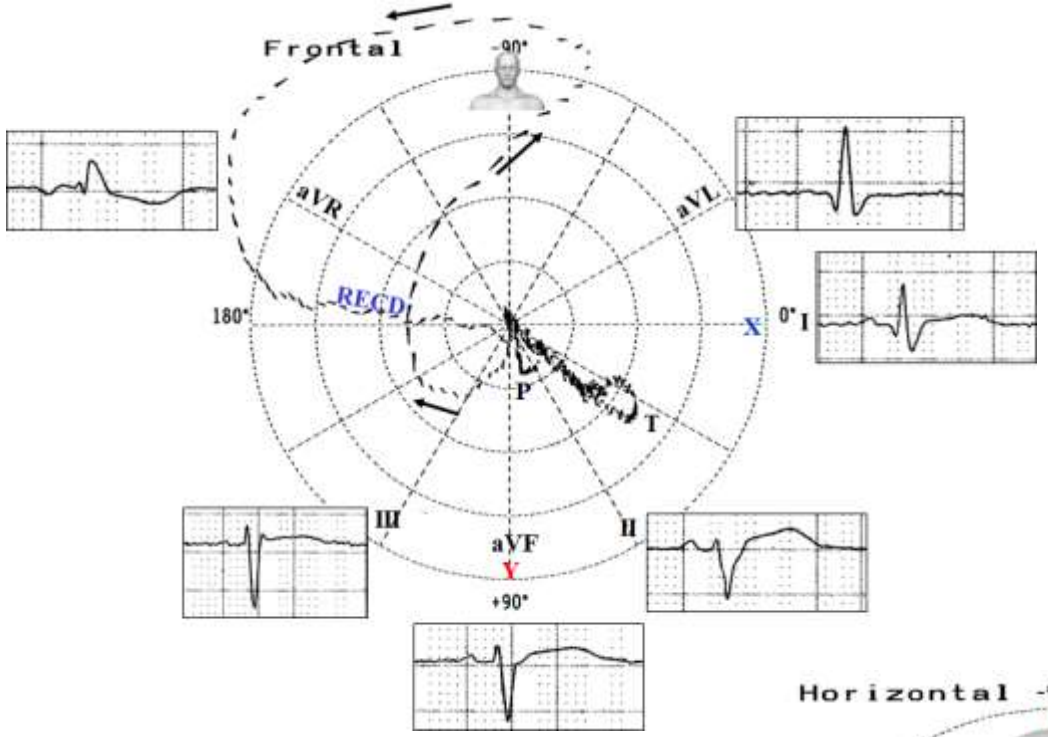
QRS loop of clockwise rotation, posterior shift and with initial and final delay. R of V4-V6 indicates probable LV free wall severe fibrosis. Anterior electrically inactive area, probable apical extension.

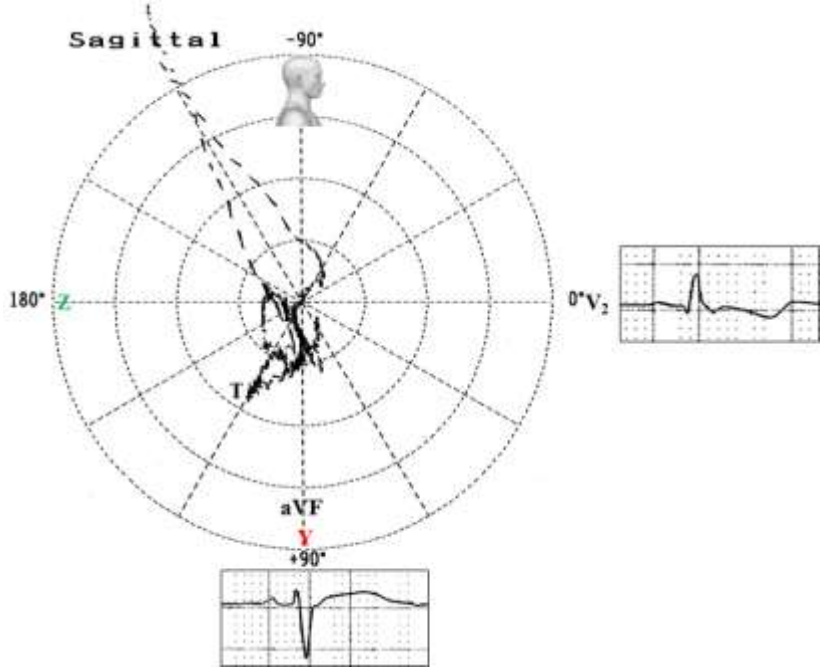
Name: CRDS; **Sex:** M; **Age:** 56 y/o; **Ethnic group:** Caucasian; **Weight:** 67 Kg; **Height:** 1.68 m;
Date: 15/05/2008; **Medications in use:** Amiodarone 300 mg daily



Clinical Diagnosis: Chronic chagasic myocarditis.
ECG diagnosis: Extreme left axis deviation (QRS axis -90º: LAFB + complete RBBB + anterolateral low voltage suggestive of anterior fibrosis).

ECG/VCG correlation of the same patient





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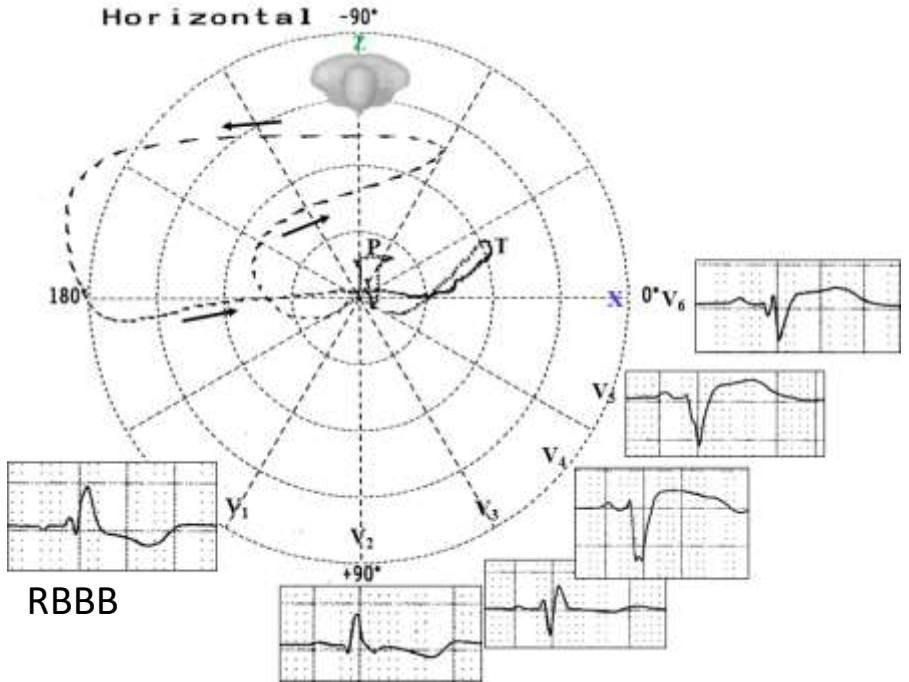
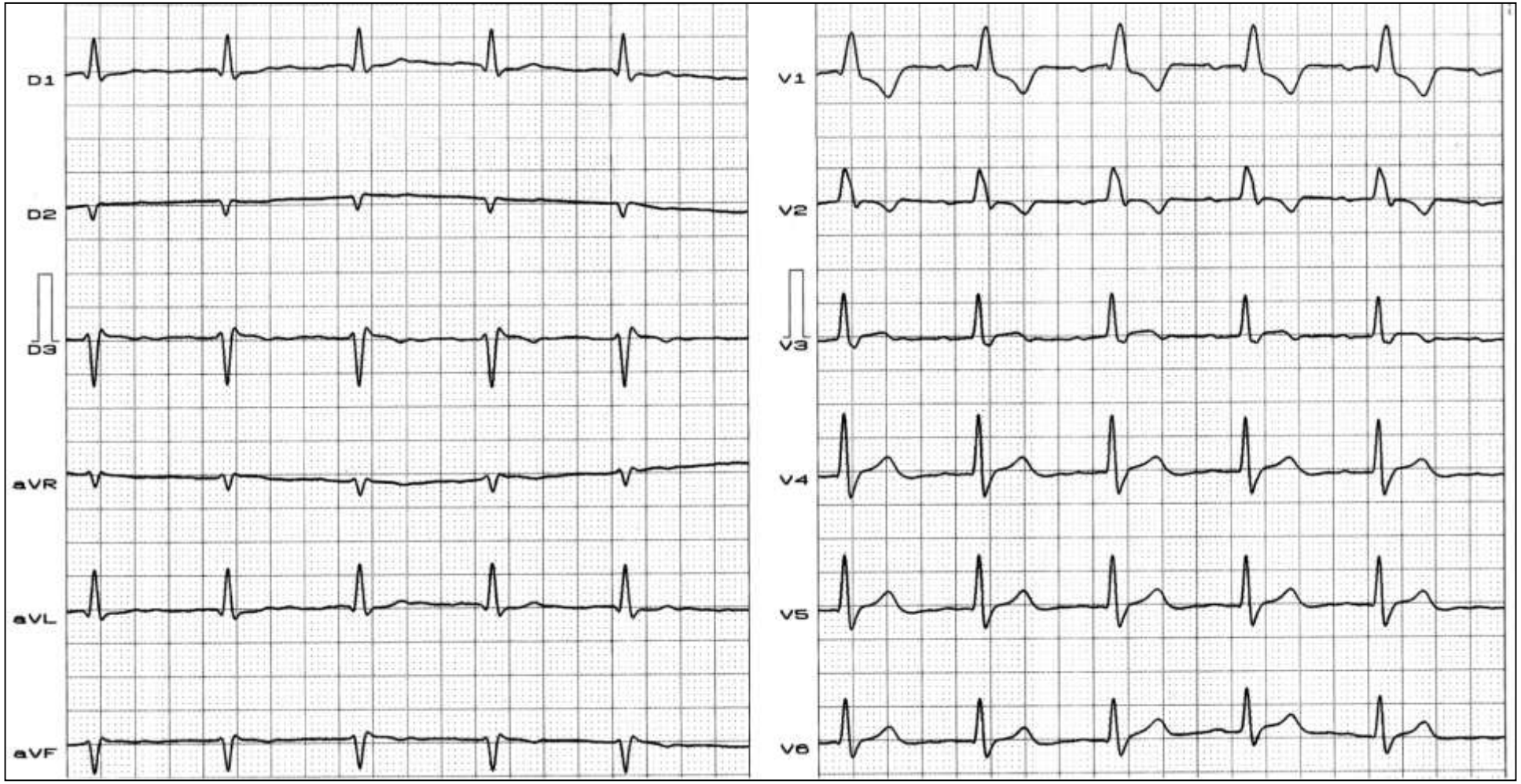
Timer	2 msec
Loop	All Loop
Sagittal	Right
Z Axis	Back
Filter	Hum
	Muscle
	Drift



RBBB

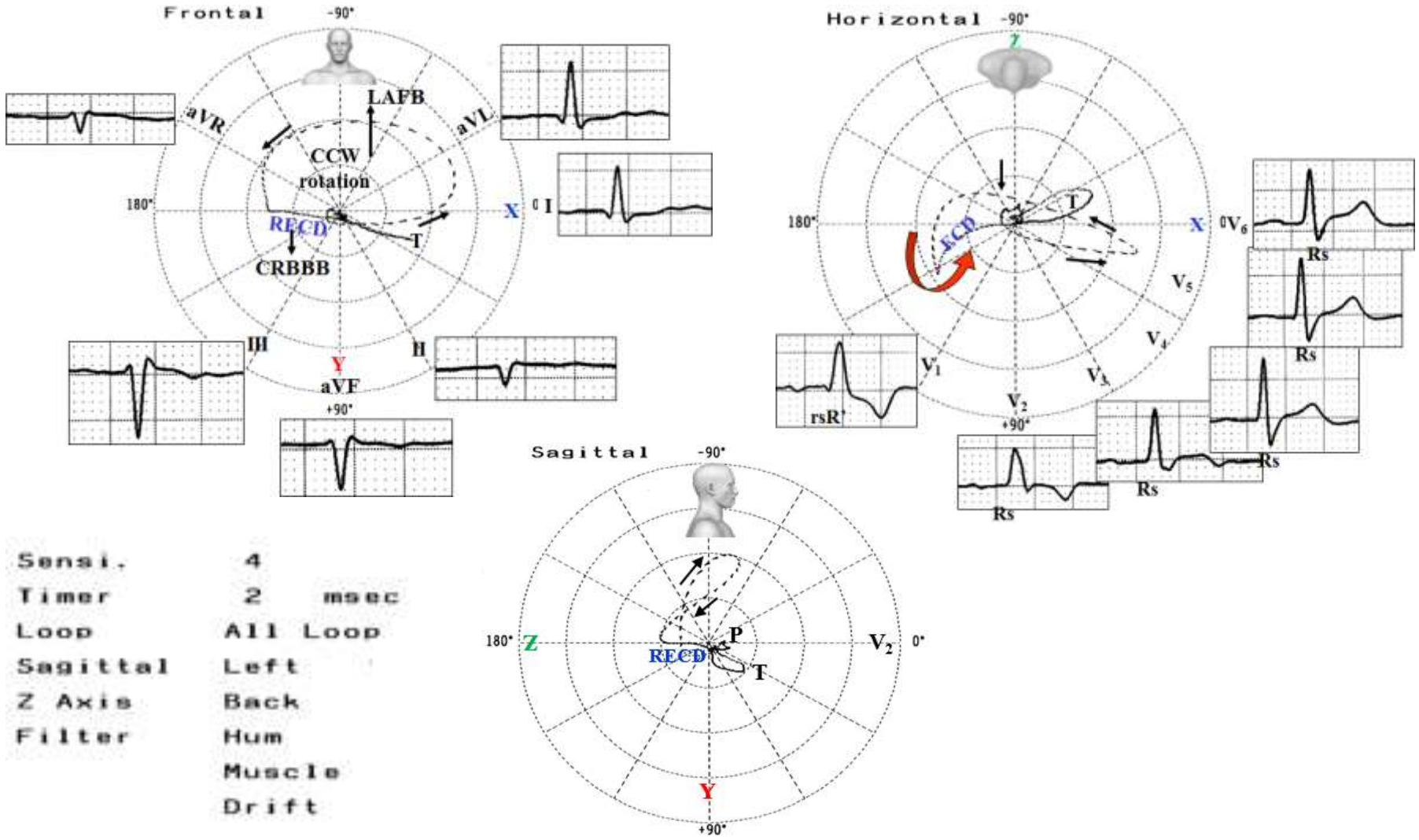
Low apical voltage

Name: OO; **Sex:** M; **Age:** 51 y/o; **Ethnic group:** Asian; **Weight:** 71 Kg; **Height:** 1.679 m;
Date: 04/19/2004; **Medication in use:** nothing stated.



Clinical diagnosis: chronic chagasic heart disease, dromotropic form + gout.
Echocardiographic diagnosis: telesystolic prolapse with mild escape. EF: 73%
ECG diagnosis: HR: 77 bpm, P wave difficult to visualize in the frontal plane; PR: 200 ms; SÂQRS –70º; QRSd: 150 ms; Rs from V2 to V6.
Conclusion: CRBBB + LAFB + PAF (prominent anterior forces). The difficult visualization of P wave in the FP may indicate a certain degree of atrial wall fibrosis (sino-ventricular conduction).

ECG/VCG correlation



FP: Extreme shift of SÂQRS in left superior quadrant, QRS loop CCW rotation, qR in I and aVL, SIII > SIII = LAFB. RECD located in the right portion of orthogonal X lead: complete RBBB.

HP: Initial forces preserved, afferent limb behind the X line, RECD located in the right anterior quadrant with glove-finger morphology, T loops directed to the back and leftward: CRBBB Grishman or Kennedy type A. Triphasic pattern in V1, broad final S wave in left leads: CRBBB.

Holter and stress test

- Holter is normal
- Stress test:
  - Max. heart rate 154/min
  - Normal performance (200 watts), normal blood pressure response
  - At the ned of the exercise 4-5 ventricular ectopics (symptomatic)
    - We don’t have the stress protocol and therefore we don’t know the morphology of the effort-induced ventricular ectopic beats

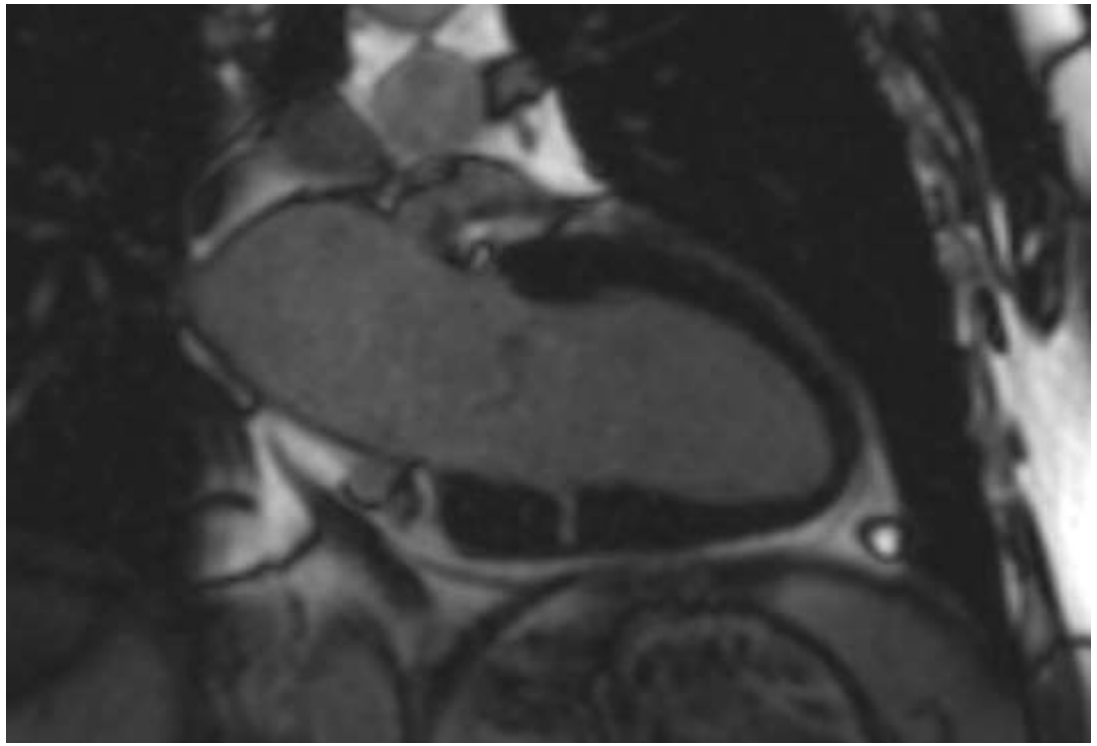
Echocardiography

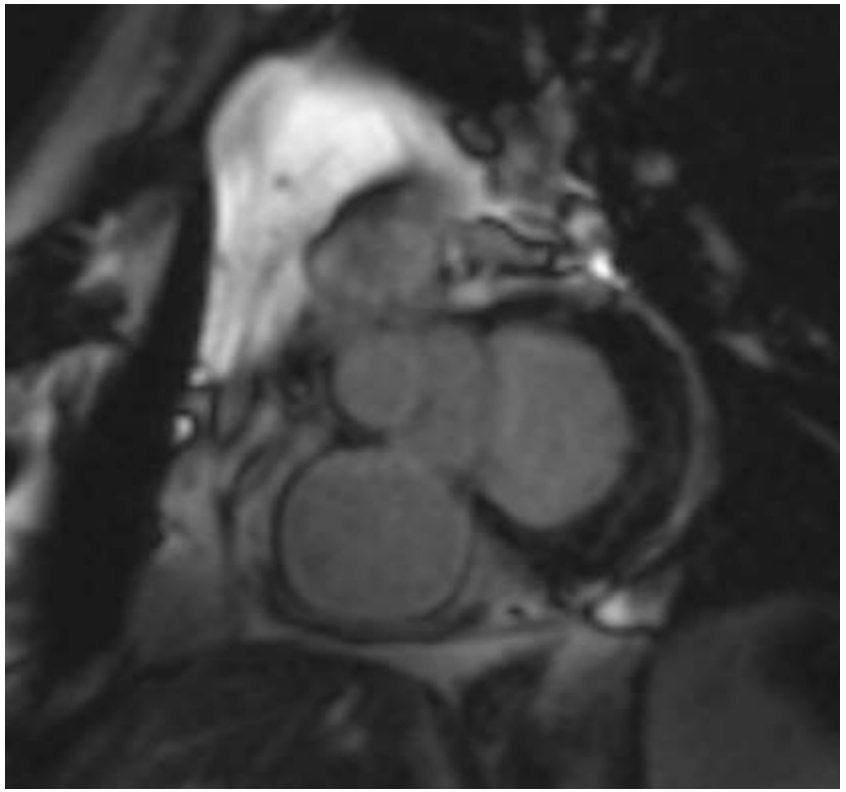
- RV normal, RV pressure normal
- No valvular disease
- Mild hypertrophy in the LV (max. 13 mm)
- LVEDD 51 mm
- EF >60%

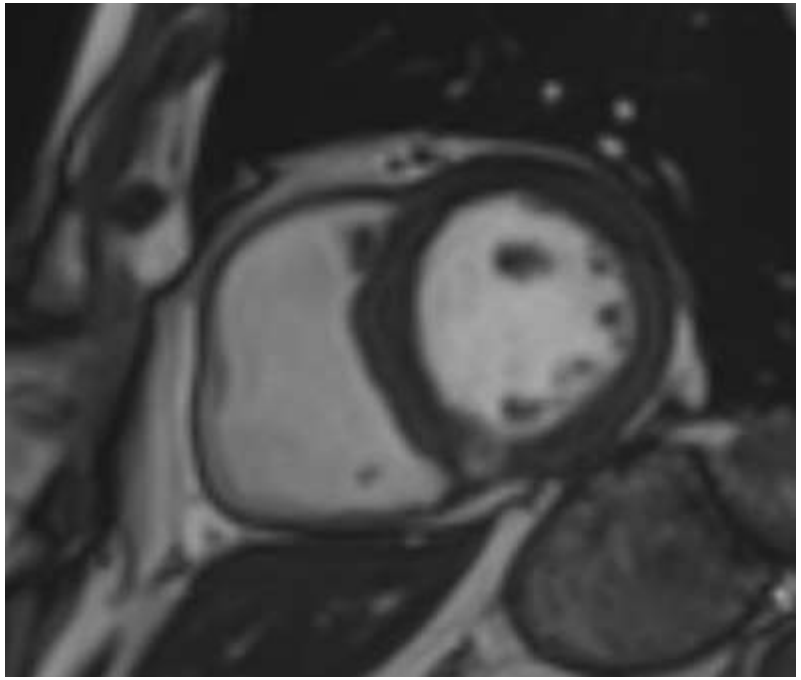
Cardiac MRI

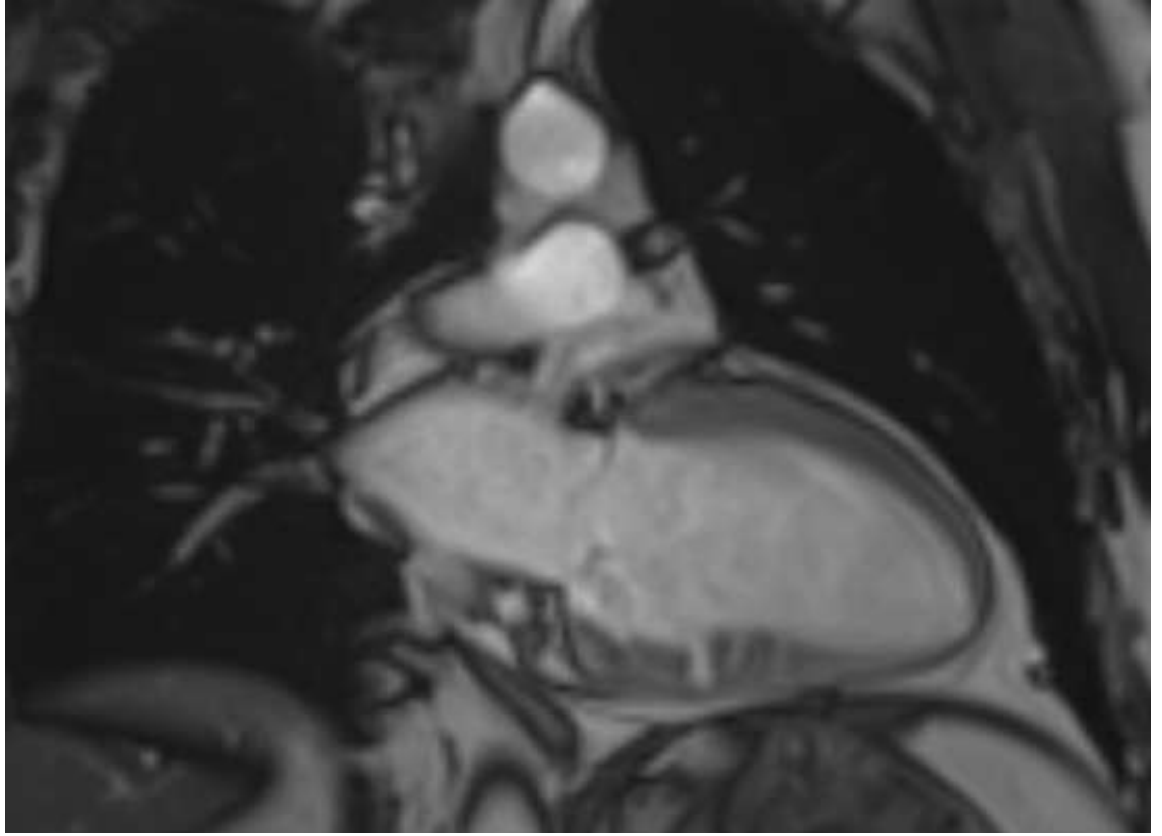
- Mild hypertrophy (septum 14 mm, PW 13 mm)
- In the posterior wall **??*** of the LV there are 3 prominent trabeculae, not a typical location for trabeculated cardiomyopathy (non-compactation)
- Late enhancement (gadolinium):
  - Not in the area with prominent trabeculae
  - Midwall late enhancement in the basal part of the lateral wall, also anteroseptal , but the late enhancement does correlate with the wall hypertophy * **Observation The posterior wall of the left ventricle does not exist !!!!!! Bayes de Luna!!!!**

- **Antoni Bayés de Luna et al. A new terminology for left ventricular walls and location of myocardial infarcts that present Q wave based on the standard of cardiac magnetic resonance imaging: a statement for healthcare professionals from a committee appointed by the International Society for Holter and Noninvasive Electrocardiography Circulation. 2006 Oct 17;114(16):1755-60. doi: 10.1161/CIRCULATIONAHA.106.624924.**









Comments

- The MI findings are compatible with Chagas disease
- At the moment, we don’t know about possible travel history to Latin America or the USA
- My question is: do you think that we have to consider Chagas?

Answer: No Why? Explantion in the next slides

In chronic Chagas cardiomyopathy the myocardial damage typically causes regional contraction disturbances in the left ventricle and the virtually pathognomonic **apical aneurisms** Global LV dilatation and systolic dysfunction are also often seen as the disease progresses. When heart failure supervenes, it is usually with biventricular manifestations and systemic congestion can be more impressive when compared to pulmonary congestion. Patients with cardiac form of CD are seen frequently in cardiac units and clinics all around South and Central America. They usually present with heart failure symptoms during recurrent hospital admissions. In many cases, symptoms and signs of systemic congestion are very prominent. They usually complain of lower limbs edema, weight gain, increase in abdominal volume, and pain associated with hepatomegaly. This conspicuous form of right-sided heart failure presentation was well described since the first reports on clinical CD and still puts a challenge to treatment. Patients need high doses of diuretics and vasodilators and sometimes the use of intravenous inotropes, although it, with no proven benefit on mortality, is warranted as a symptomatic treatment resource Because of these peculiar aspects of CD cardiomyopathy, diagnostic tools capable of detecting early myocardial involvement in both ventricles can represent a first step towards an early and effective treatment of these patients before the development of more advanced fibrotic and irreversible changes. CMR characteristics show significantly higher LV end-diastolic volumes, higher end-systolic volumes, and lower LVEF. CMR-derived LV volumes and LVEF show high correlation with echocardiographic measurements. The presence of wall motion abnormalities determined by CMR is more frequently found in the **inferolateral and apical segments**. CMR show apical dyskinesia, DE distribution is highly heterogeneous being predominantly subendocardial and transmural of total segments with DE. The presence of DE is significantly associated with lower LVEF, RVEF and higher indexed LV end-diastolic volume and left atrial area DE is detected in a lower proportion in patients previously treated with benznidazole

Disorders that may involve the left ventricular apex

There are many disorders that may involve the left ventricular apex; however, they are sometimes difficult to differentiate. The spectrum of diseases that most frequently affect the apex of the left ventricle include:

1. Takotsubo cardiomyopathy (“octopus trap”): transient apical ballooning syndrome, apical ballooning cardiomyopathy, stress-induced cardiomyopathy, Gebrochenes-Herz-Syndrome, broken heart, and simply stress cardiomyopathy. A bulging out of the left ventricular apex with a hypercontractile base of the LV is often noted. Its hallmark is bulging out of the apex of the heart with preserved function of the base.
2. Left ventricular aneurysms and pseudoaneurysms
3. Apical diverticula
4. Apical ventricular remodelling
5. Apical hypertrophic cardiomyopathy (ApHCM) (Cisneros 2011)
6. Left ventricular non-compaction
7. Arrhythmogenic right ventricular cardiomyopathy/dysplasia (ARVC/D) with left ventricular involvement
8. Left ventricular false tendons: fibrous or fibromuscular bands that stretch across the LV from the septum to the free wall. They can also tether to a papillary muscle, but unlike the chordae tendineae, do not connect to the mitral leaflets. They are anatomic variants that should not be mistaken for abnormalities such as tumors, subaortic membranes, thrombus borders, septal hypertrophy.
9. **Chronic chagasic myocardiopathy**

With an emphasis on the diagnostic criteria and imaging features. In this setting cardiac imaging methods can provide the clue to obtaining the diagnosis.

Chagas disease outside of Latin America remains poorly recognized. Most US immigrants from endemic countries have limited knowledge of Chagas disease or of their risk of being infected, and many have limited access to diagnostic and treatment facilities because of insurance or immigration issues. Infected individuals are widely scattered across >40 states,making comprehensive assessment and screening challenging. Most US healthcare practitioners have limited awareness and knowledge of Chagas disease and thus are unlikely to screen those at risk.

Similar difficulties are seen in Europe, where the high diversity of health systems and high mobility of migrants among the states of the European Union create additional challenges in the management of Chagas disease.The control of this disease is also difficult in other areas with smaller high-risk immigrant populations, including Japan and Australia.

As globalization continues, healthcare providers and health systems outside of Latin America need to be equipped to recognize, diagnose, and treat Chagas disease and to prevent further disease transmission. Indeed, transmission of *T cruzi* is not confined to endemic countries only but also occurs in nonendemic countries through various nonvector pathways, including **blood transfusion, congenital transmission, and organ transplantation.**

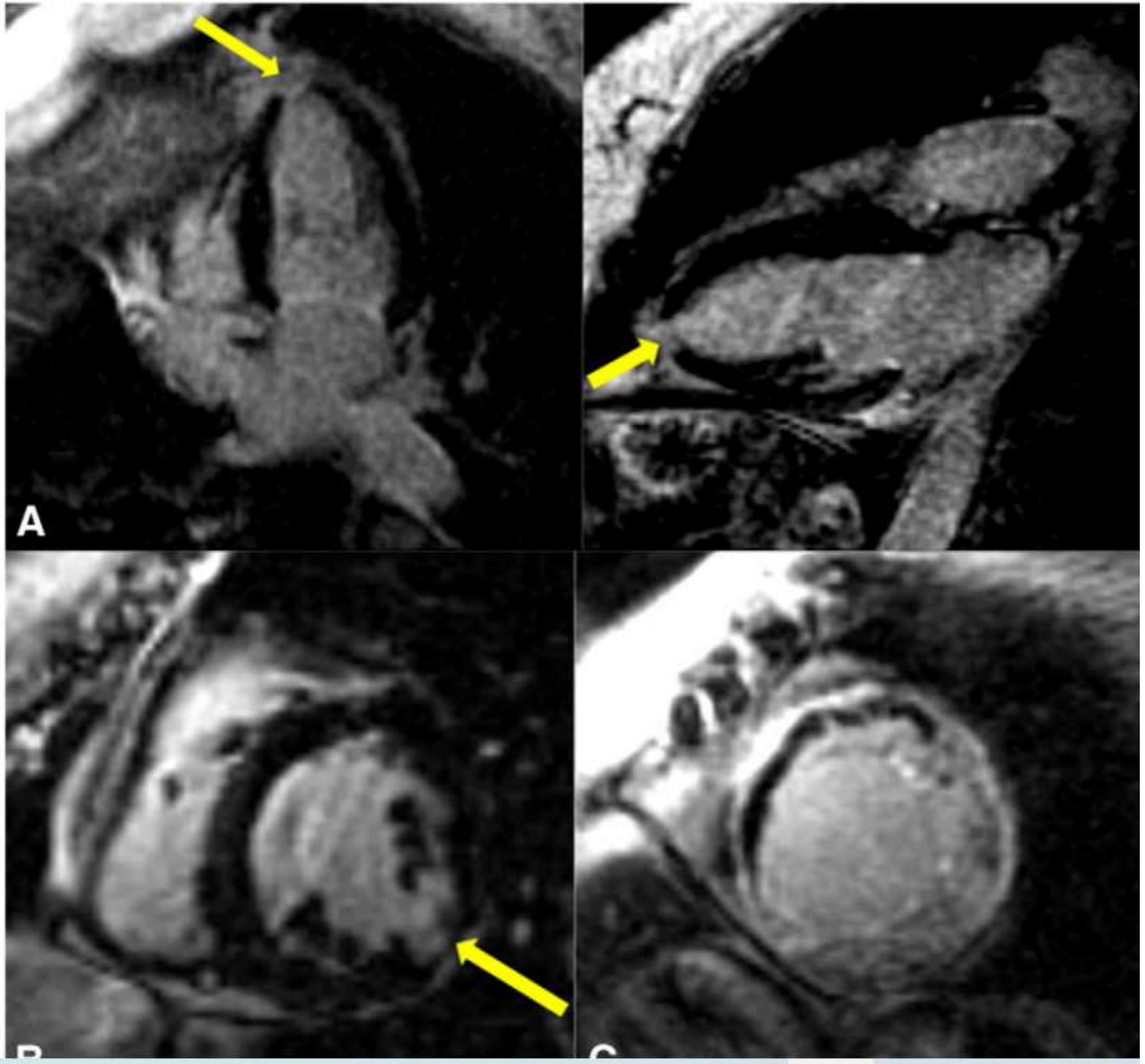
Although local vector-borne transmission occurs in the southern half of the United States, the vast majority of infected US residents are immigrants from endemic countries of Latin America. In addition, transmission can occur in nonendemic areas through blood transfusion, organ transplantation, and congenital transmission from an infected mother.

In recognition of this, the American Heart Association and the Inter-American Society of Cardiology commissioned this statement to increase global awareness among providers who may encounter patients with Chagas disease outside of traditionally endemic environments.

Cardiac Magnetic Resonance

CMR has a superior capability for anatomic and functional evaluation of all cardiac chambers, provides direct measurement of both RVEF and LVEF, detects mural thrombosis, and allows valuable tissue characterization. In particular, late enhancement imaging of gadolinium injected intravenously is useful for the qualitative and quantitative assessment of myocardial fibrosis.1-4 These studies further highlighted the striking feature Chagas cardiomyopathy, describing patients who develop malignant arrhythmia in the absence of global ventricular systolic dysfunction but showing focal areas of myocardial fibrosis. 5 Thus, CMR has strong potential for improving the prognostic evaluation of patients with CCC beyond the Rassi score, perhaps allowing restratification of those with intermediate risk of death. Despite some limitations for the widespread use of CMR in low-income countries, the use of this method can be strongly encouraged on the basis of its diagnostic and prognostic capabilities.

1. ***Regueiro A, et al. Myocardial involvement in Chagas disease: insights from cardiac magnetic resonance.Int J Cardiol. 2013; 165:107–112. doi: 10.1016/j.ijcard.2011.07.089***
2. ***Lee-Felker SA, et al. Value of cardiac MRI for evaluation of chronic Chagas disease cardiomyopathy.Clin Radiol. 2016; 71:618.e1–618.e7. doi: 10.1016/j.crad.2016.02.015***
3. ***Garg G, et aI. Cardiac $^{(18)}$F-FDG uptake in Chagas disease.J Nucl Cardiol. 2016; 23:321–325. doi: 10.1007/s12350-015-0218-0.***
4. ***Prado CM, et al. Micro-positron emission tomography in the evaluation of Trypanosoma cruzi-induced heart disease: comparison with other modalities.Am J Trop Med Hyg. 2009; 81:900–905. doi: 10.4269/ajtmh.2009.09-0338***
5. ***Tassi EM, e al Relationship between fibrosis and ventricular arrhythmias in Chagas heart disease without ventricular dysfunction.Arq Bras Cardiol. 2014; 102:456–464***



Delayed-enhancement (DE) Cardiac Magnetic Resonance (CMR) patterns:

(A) 4-chamber (left) and 2-chamber (right) CMR showing **apical transmural** DE;

(B) short-axis CMR showing **subepicardial DE in the inferolateral segmen**t;

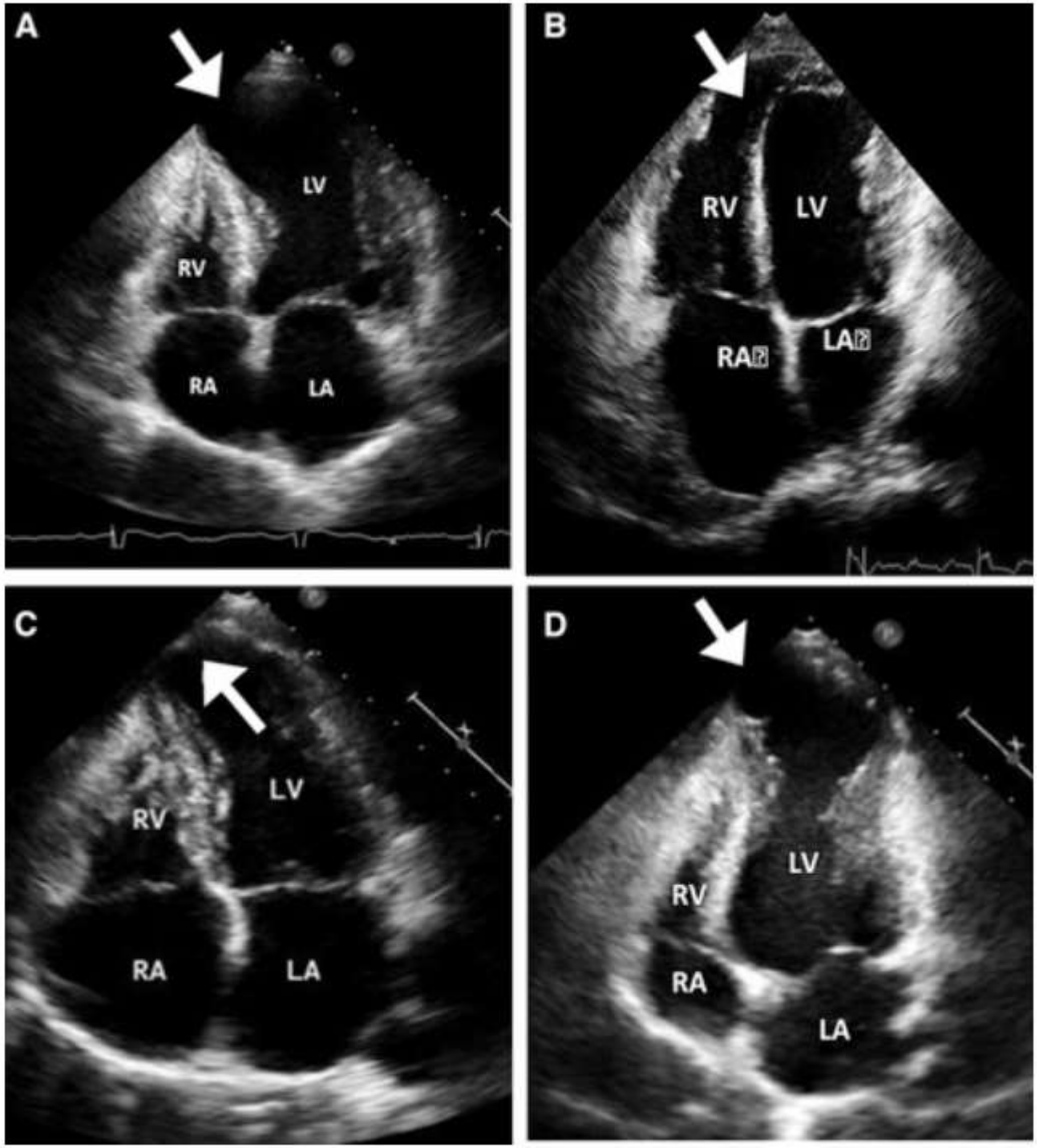
(C) short-axis CMR showing a case of **diffuse circumferential and transmural delayed enhancement.** As shown in these examples, CMR findings in Chagas' disease can sometimes mimic those observed in coronary artery disease.

Chagas cardiomyopathy is the most important clinical manifestation of Chagas disease, resulting in the majority of Chagas morbidity and mortality. Although generally classified as having a hemodynamic pattern of dilated cardiomyopathy, the typical predominant distribution of fibrosis **to the basal lateral and apical regions** of the LV and involvement of the sinus node and electric conduction system distinguish Chagas disease from other cardiomyopathies. Clinical manifestations of Chagas heart disease result from electric conduction abnormalities, myocardial contractile dysfunction, arrhythmias, or thromboembolism. In most studies, sudden death is the most common overall cause of death (55%–60%), followed by heart failure (25%–30%) and embolic events (10%–15%), but the proportions vary depending on the population studied. The main ventricular arrhythmogenic substrates in Chagas heart disease are necrotic and fibrotic myocardial lesions. These lesions disrupt the intercellular junctions, change the cardiac electric potential, and form the basis of reentrant circuits for ventricular arrhythmias. Although ventricular arrhythmia can arise from various locations, there is good topographic correlation among myocardial perfusion deficits, wall motion abnormalities, and foci of VT. The LV **inferolateral region** is the most common focus. The extension of myocardial fibrosis as assessed by delayed enhancement on cardiac magnetic resonance (CMR) imaging can identify high-risk patients. Alternatively, the use of the Selvester QRS scoring system, which estimates scar size by quantifying changes in Q-, R-, and S-wave duration, amplitude, and morphology on the 12-lead ECG, has shown good correlation with MRI and retrospectively with a history of VT.

.**http://cardiolatina.com/wp-content/uploads/2018/09/Chronic-chagasic-cardiomyopathy-with-apparent-minimal-repercussion-and-surprising-electro-vectorcardiograpic-features-3.pdf**

Most Common Echocardiographic Findings in Chronic Chagas Disease

Segmental wall motion abnormalities: hypokinesis, akinesis, or dyskinesia
Inferior-inferolateral wall, usually basal segments
LV apex
Preserved septal contraction
LV aneurysm
LV diastolic dysfunction
Dilated cardiomyopathy
RV dysfunction
Mural thrombus, mainly at LV apex
Mitral and tricuspid regurgitation
Segmental wall motion abnormalities: hypokinesis, akinesis, or dyskinesia
Inferior-inferolateral wall, usually basal segments



Ventricular aneurysms in several patients with Chagas cardiomyopathy.

A range of ventricular aneurysms in patients with Chagas cardiomyopathy. **A**, **C**, and **D**, Left ventricular (LV) apical aneurysm. **B**, Right ventricular (RV) apical aneurysm. LA indicates left atrium; and RA, right atrium.

Most Common Presenting Signs in Patients With CCC

HF: exertional dyspnea, orthopnea, peripheral edema, and fatigue
Bradyarrhythmia/tachyarrhythmia: palpitations, presyncope, syncope, aborted sudden death
Thromboembolic events: symptoms suggesting transient ischemic attack or stroke, pulmonary or systemic emboli
Microvascular abnormalities: precordial or retrosternal chest pain that is atypical for angina without evidence of epicardial coronary artery disease
HF: exertional dyspnea, orthopnea, peripheral edema, and fatigue

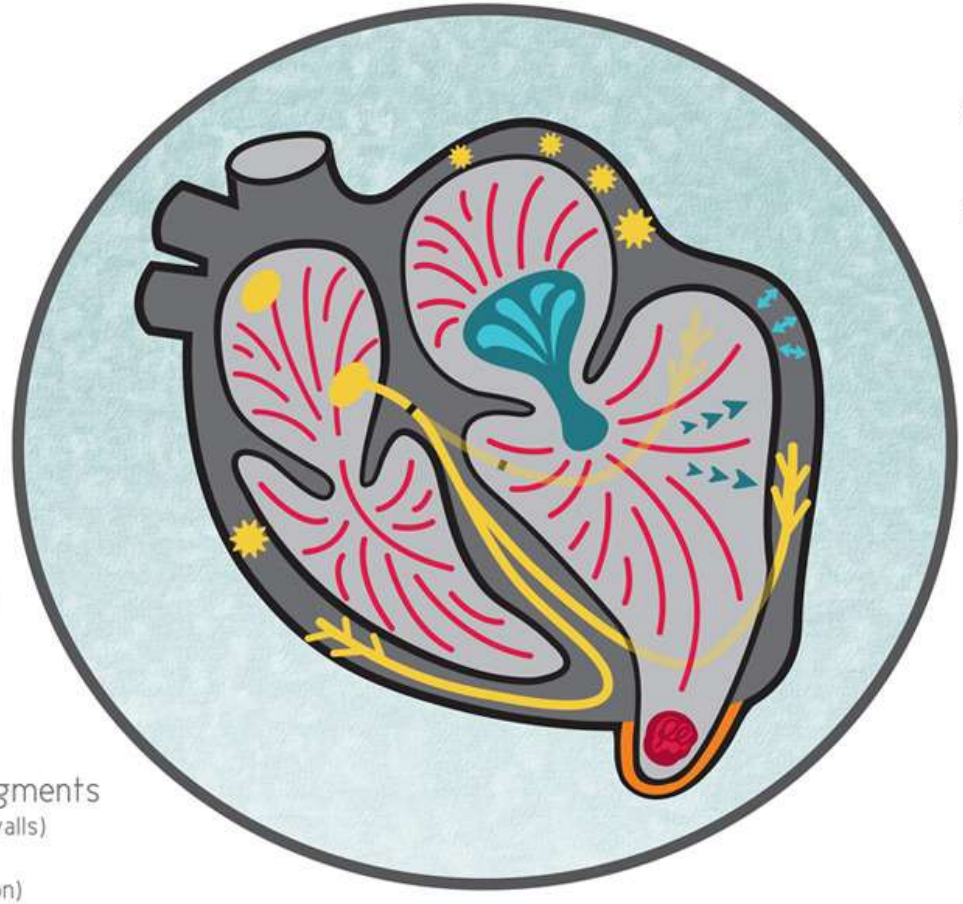
Risk Factors for Occult Chronic Chagas Disease in People Living in Nonendemic Environments
Patients who were born in or have lived for an extended period in Trypanosoma cruzi–endemic zones
A child of a mother from a T cruzi–endemic zone
Travelers with stays in T cruzi–endemic zone
Resident or former resident of the southern United States, especially in rural areas of states known to have the vector
Occupation brings patient in contact with T cruzi (laboratory transmission)

1 ⟩ CARDIAC RHYTHM

- Sinus Node Dysfunction
- Atrioventricular Block
- Bundle Branch Block
  (most commonly RBBB +/- left anterior fascicular block)
- Ventricular Arrhythmias
  (PVC's, VT)
- Atrial Fibrillation

2 ⟩ MYOCARDIAL ABNORMALITIES

- Segmental Wall Motion Abnormalities
  (apical, inferior, inferolateral, lateral)
- Global Wall Motion Abnormalities
- Dilated Cardiomyopathy
  (left, right, or bi-ventricular,
- Functional Mitral and/or Tricuspid Regurgitation



3 ⟩ ANEURYSMS

- Left Ventricular Apical
- Other Left Ventricular Segments
  (mainly inferior and inferolateral walls)
- Right ventricular (uncommon)

4 ⟩ THROMBO-EMBOLISM

- Risk Factors:
  (left ventricular aneurysm, thrombus, systolic dysfunction, atrial fibrillation)
- Stroke > Systemic

Diagnostic laboratory methods are very easy to preform. Some chagasic patients with conspicuous ECG and ventricular regional abnormalities may be asymptomatic hard workers. The appropriate use of several diagnostic methods will detect the cardio-vascular dysfunction in virtually all patients, and help in establishing both the diagnosis and prognosis. **Serologic tests -** The etiologic diagnosis is routinely performed with methods that detect circulating antibodies that bind to parasite antigens. The most commonly used tests are based upon **complement fixation, immunofluorescence, or ELISA assays**, that, carefully standardized, achieve sensitivity and specificity rates higher than 90%. Chagas' disease is diagnosed with greater sensitivity by the detection of *T. cruzi* specific sequences of DNA, using molecular biology approaches. These later techniques also have the potential for improving the diagnostic and prognostic characterization of the disease, on the basis of parasite strain identification .