

**English/Portuguese**

**Concomitant Tombstone appearance and Lambda-like ST Segment Elevation during Hyperacute Myocardial Infarction: an explosive association**

**Aparecimento concomitante da morfologia “lápide” e Elevação do Segmento ST semelhante a letra lambda (“Lambda-like” Wave) durante a fase hiperaguda do Infarto do Miocárdio: uma associação explosiva**

**Raimundo Barbosa-Barros, Andrés Ricardo Pérez-Riera & Frank Yanowitz**

## Case Report

*RNS, 47-year-old man with known CAD (history of stent implant for right anterior descending (RAD) and circumflex (Cx) arteries one year ago), hypertension, smoker, alcoholism, and irregular use of medication.*

**Chief Complaint:** chest pain.

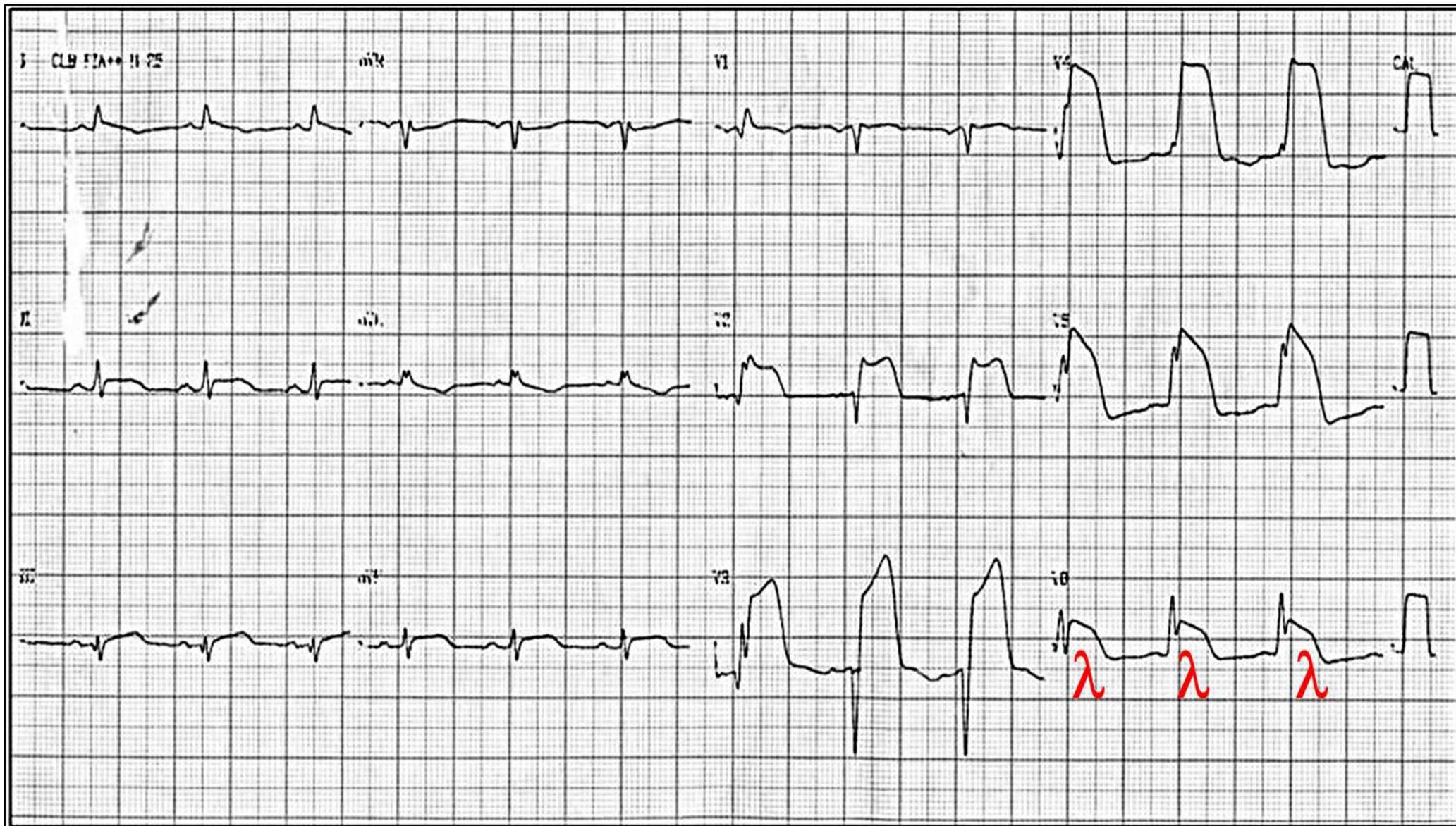
**History of present illness:** patient woke up during the night with very intense retrosternal “burning” chest pain.

*He was admitted to the ER of the hospital after one hour from the onset of pain. The first ECG (next slide) was made and he was rapidly sent to the Resuscitation Room with decreasing consciousness. On initial physical examination he was non-responsive and without pulses, and the monitor indicated ventricular fibrillation. Cardiopulmonary resuscitation (CPR) was started immediately. Sinus rhythm was restored after the second DC shock. Since the hemodynamic lab was unavailable, streptokinase was administered in the Resuscitation Room.*

*RNS, masculino de 47 anos de idade, portador de doença arterial coronária (DAC) conhecida, com relato de implante de stents para a artéria descendente anterior (ADA) e circunflexa(Cx) há um ano. Hipertenso(em uso irregular da medicação) fumante, etilista.*

*Queixa principal: dor no peito.*

*História da doença atual: refere que acordou durante a noite com dor no peito retroesternal muito intensa em "queimação". Deu entrada na sala de emergência(SE) do hospital após uma hora do início do episódio. O primeiro ECG da admissão se mostra na próxima diapositiva. O paciente foi enviado rapidamente para a sala de reanimação com diminuição do nível de consciência. Não responsivo e sem pulsos ao exame inicial, e o monitor mostrava fibrilação*



1. Which is the ECG diagnosis?
2. Which is the culprit artery?
3. Appropriate approach?

1. **Descreva o diagnóstico eletrocardiográfico**
2. **Qual a artéria culpada e porque?**
3. **Qual abordagem adequada?**

**Colleagues opinions**

Proximal LAD occlusion with wrap around giving picture of acute inferolateral MI. Needs emergency PTCA.



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**Thank you Andrés and Raimundo for this beautiful anterior wall STEMI.**

The ECG shows normal sinus rhythm with normal PR interval, QRS duration; The frontal plane QRS axis is approximately +10 degrees. Marked tombstone appearing ST segment elevation is seen in V2-6 with maximal elevation in V3-5. There is also slight ST elevation in most frontal plane leads except slight ST depression in aVR. Q and QS waves are also noted in V1-3.

I believe this is an acute total occlusion of the left anterior descending (LAD) artery distal to the 1st diagonal.

Urgent revascularization is indicated, preferably with a PCI approach.

**Best regards,  
Professor Frank Yanowitz M.D.**

Estimado Profesor Andrés muy interesante caso. Las alteraciones del segmento ST son diagnósticas de una corriente lesión subepicárdica probablemente en relación al tercio medio, de la DA sobre un miocardio con cicatriz septal. Por lo agudo del cuadro clínico y la cantidad de miocardio comprometido plantearía la hipótesis de un accidente coronario en relación al stent de la DA ya sea por trombosis intra stent, o disección coronaria peri stent. DA no dominante.

La conducta es realizar coronariografía e idealmente evaluar lumen con ivus.

Gracias

Atentamente y saludos

**Claudio Santibáñez Catalan**

Dear Professor Andrés very interesting case. ST segment elevation are diagnostic of an injury subepicardial current probably in relation to the middle third of the LAD on a septal myocardial scar. As acute clinical picture and the amount of compromised myocardium would raise the hypothesis of a coronary stent in relation to the accident of LDA either stent thrombosis, or coronary dissection peri-stent. LDA not dominant.

The approach is ideally perform coronary angiography with intravascular ultrasound evaluation. Although arteriography has been the "gold standard" for imaging arterial anatomy, recent data have confirmed that even sophisticated arteriographic imaging substantially underestimates the degree of residual lesions, and that future observations and end-points for treatment will most likely be determined by data accumulated by computed tomography, magnetic resonance imaging, angioscopy, and intravascular ultrasound.

Dear Andrés. This is most probably an LAD occlusion, maybe a late stent thrombosis. There is Sclarovsky-Birnbaum grade 3 ischemia in leads V4-V6, which indicates high risk for ventricular fibrillation in the acute occlusive phase. Grade 3 also indicates totally unprotected myocardium (sudden occlusion without collaterals, no preconditioning) and high thrombotic burden in the culprit artery. There are some ST elevations in the inferior leads. It is probably an occlusion in the mid part of the artery, which wraps around the apex extending to the inferior wall.

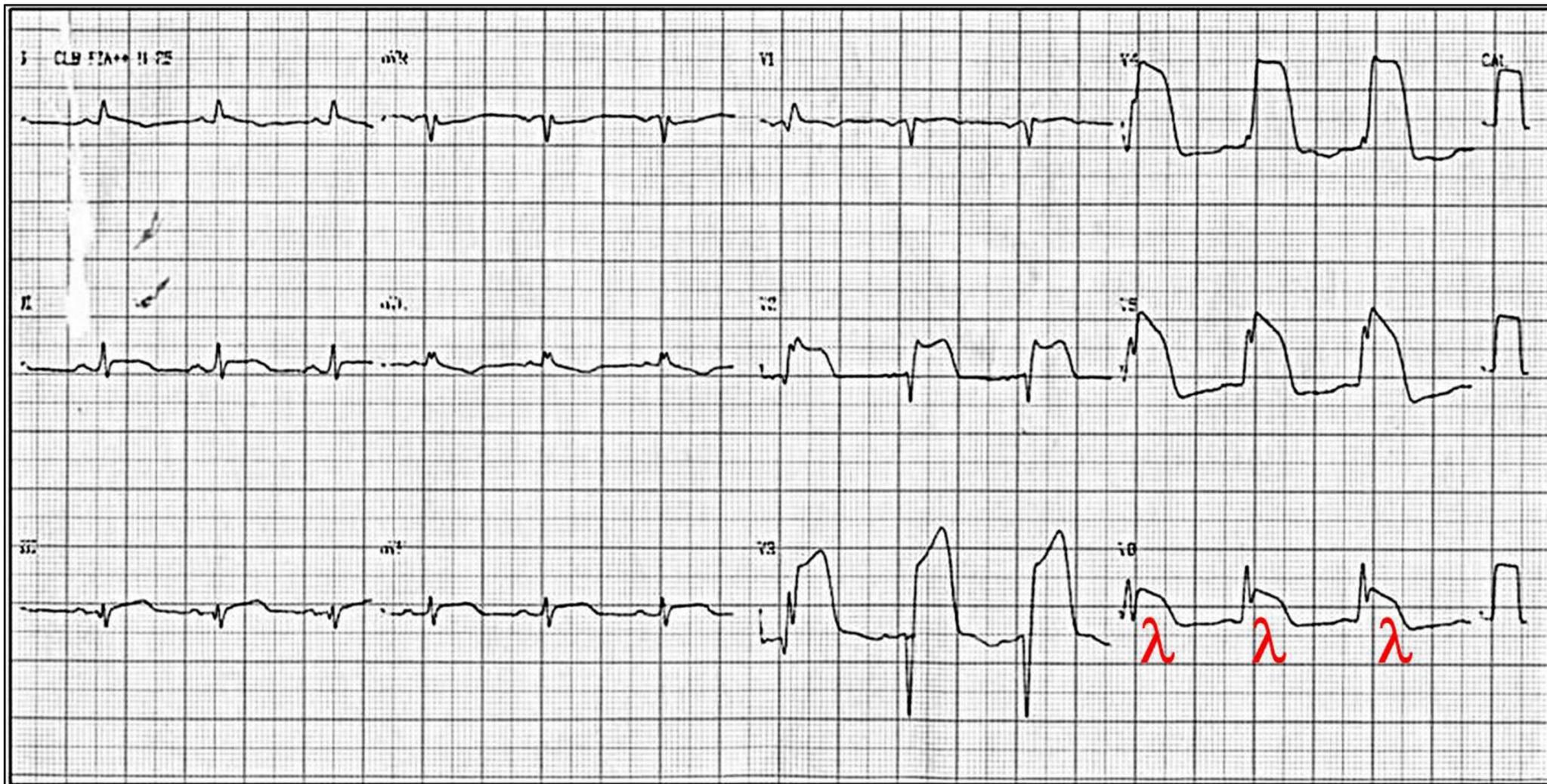
In these cases it is very important to open the artery as soon as possible and thrombolytic therapy may be considered, if primary PCI is not immediately available. If the artery remains occluded, final Q waves may develop rapidly, within 2-3 hours. Nowadays, even in these cases, with very effective antithrombotic medication given by the emergency personnel at the patient's home and immediate primary PCI with mechanical thrombectomy, the ECG may normalize almost immediately after the procedure, with minimal myocardial damage.

Kind regards

Kiell Nikus M D

# *Finals comments*

**By Raimundo Barbosa-Barros, Andrés Ricardo Pérez-Riera & Frank Yanowitz**



**Electrocardiographic diagnosis:** Marked ST segment elevation (**tombstone pattern**,\* a pattern similar to a monophasic action potential of cardiac muscle fibers) was present in leads V2 to V5. This pattern is reflected by changes in the final portion of QRS manifested by S wave disappearance in V4-V6. According to the Sclarovsky-Birnbaum Ischemia Grading System (1, 2, 3) this is called the “3rd degree” of ischemia. Patients with this pattern have increased short and long term mortality with greater final infarct size than those without these changes (“2nd degree” of ischemia). The grading system allows us to predict the degree of myocardial salvage by reperfusion therapy, the final size of infarction, and the severity of left ventricular dysfunction (2). Additionally, the tracing also illustrates J point elevation with steep ST segments and descending slopes in V5-V6 called lambda-shaped or steep down-sloping ST segments (4,5). This pattern is associated with a greater probability of ventricular fibrillation (VF) in both the scenario of acute myocardial infarction (4,5) and cases of idiopathic ventricular fibrillation or atypical Brugada pattern(6,7). In acute myocardial infarction it has specificity greater than 90% for the appearance of VF (5).\*An ST-segment elevation myocardial infarction (STEMI) having a specific pattern resembling a tombstone. It is often the earliest detected sign of acute MI. Initially, the ST segment straightens with loss of the ST-T wave angle. The T wave then becomes broader, and the ST segment elevates, losing its normal

# Left anterior descending artery (LAD) occlusion distal to the first septal perforator and before the first diagonal branch

Figure 2

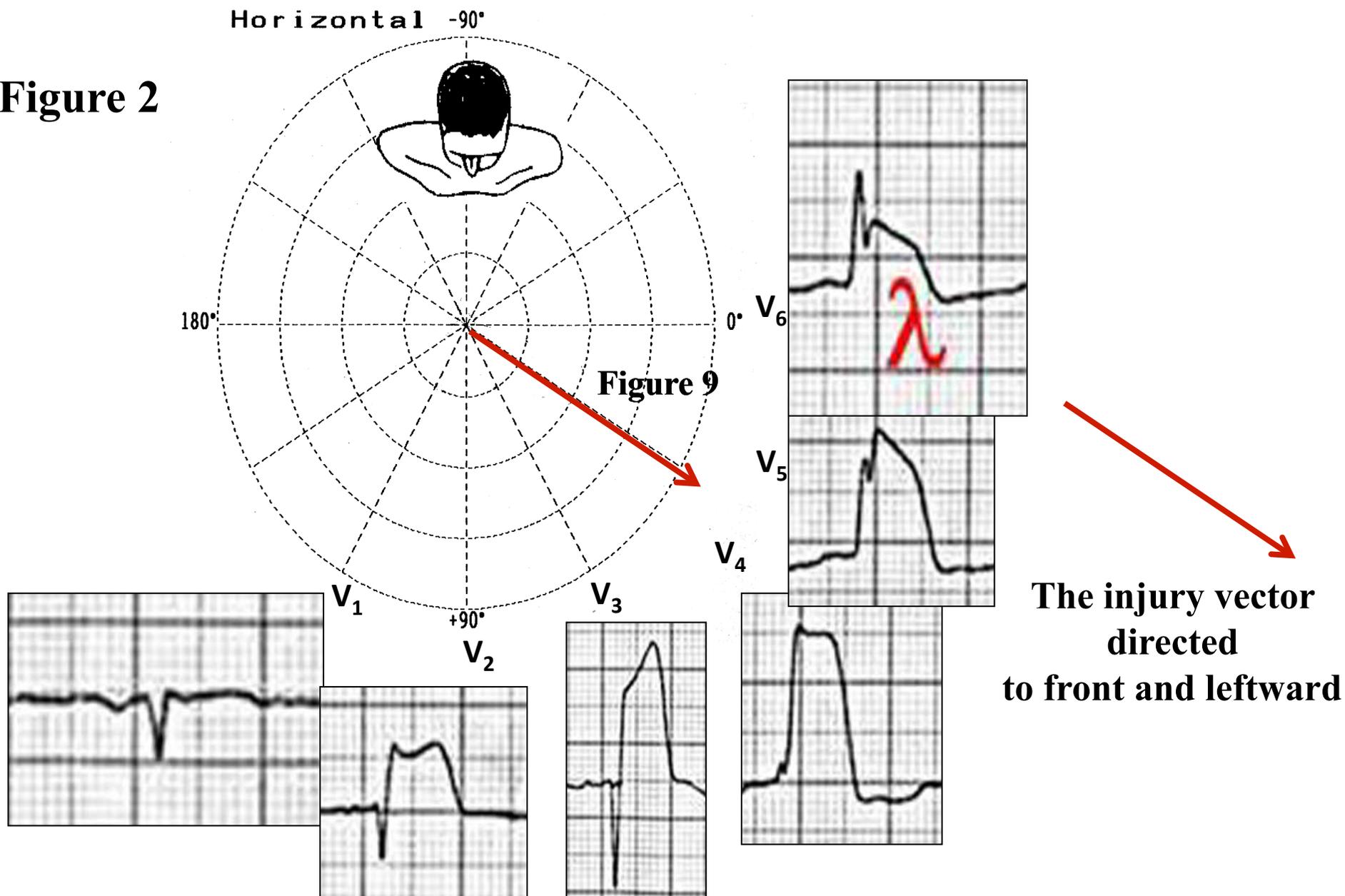
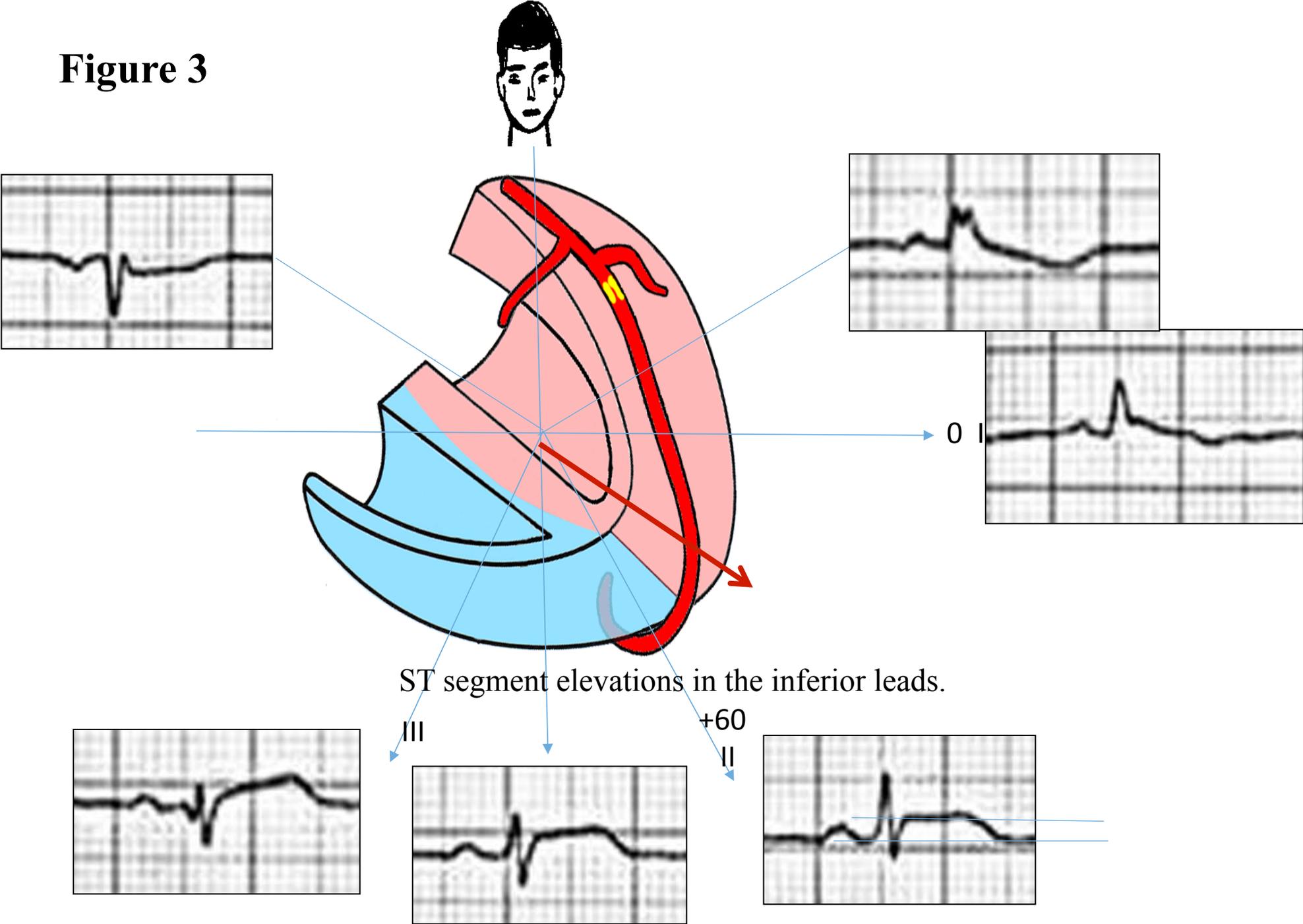
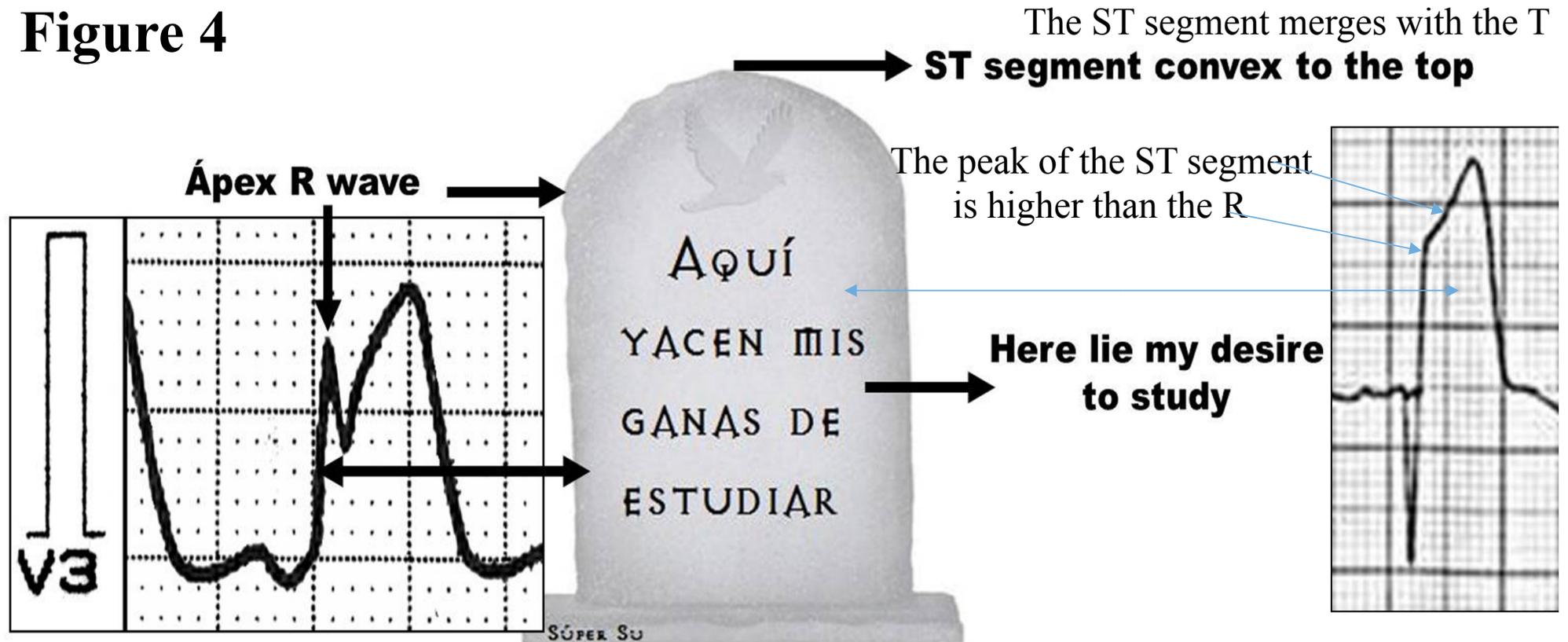


Figure 3



## Tombstone appearance

Figure 4



**Tombstoning ST-Elevation Myocardial Infarction:** Two electrophysiological mechanisms play a role in the formation of the tombstone appearance: delayed transmural conduction and intramyocardial conduction block. Additionally, in ECG1, the injury vector in the precordial leads is directed anterior and leftward. This is consistent with left anterior descending artery (LAD) occlusion distal to the first septal perforator and before the first diagonal branch: ST segment elevation from V2 to V6 and isoelectric ST segment in V1 (because the injury vector is perpendicular to V1 lead (+120°)).

The criteria of tombstoning ST-segment elevation are as follows:

1. Absent R wave or an R wave duration  $<0.04$  s with minimal amplitude;
2. Convex upward ST segment merging with the descending R or the ascending QS/QR;
3. The peak of the ST segment is higher than the R wave and;
4. The ST segment merges with the T wave.

It is very easy to recognize and discriminate tombstoning ECG from others. The magnitude of ST elevation is determined fundamentally by the severity of epicardial damage. Nevertheless, amplitude of the ST elevation is affected by **myocardial zone**, **chest structure**, and **distance of the electrode to the myocardial zone** (8; 9).

Tombstoning ECG in STEMI is not a rare event and observed among 10-26.1% of the patients(10:11). While this kind of infarction is more commonly seen in anterior localization (39.8%), it may also be observed in inferior localization (10.6%)(12).

It appears that a sudden occlusion of a coronary artery supplying a large area of unprepared myocardium; i.e. myocardium not protected by collaterals or ischemic preconditioning, results in complete transmural injury **rapidly progressing to complete MI**, resulting in this characteristic ECG pattern. The extensive nature of the myocardial infarction and the resultant left ventricular damage and dysfunction may explain the higher risk of complications and mortality associated with this finding. The higher BNP levels on presentation in patients with tombstone STEMI seem to support

**Figure 5**

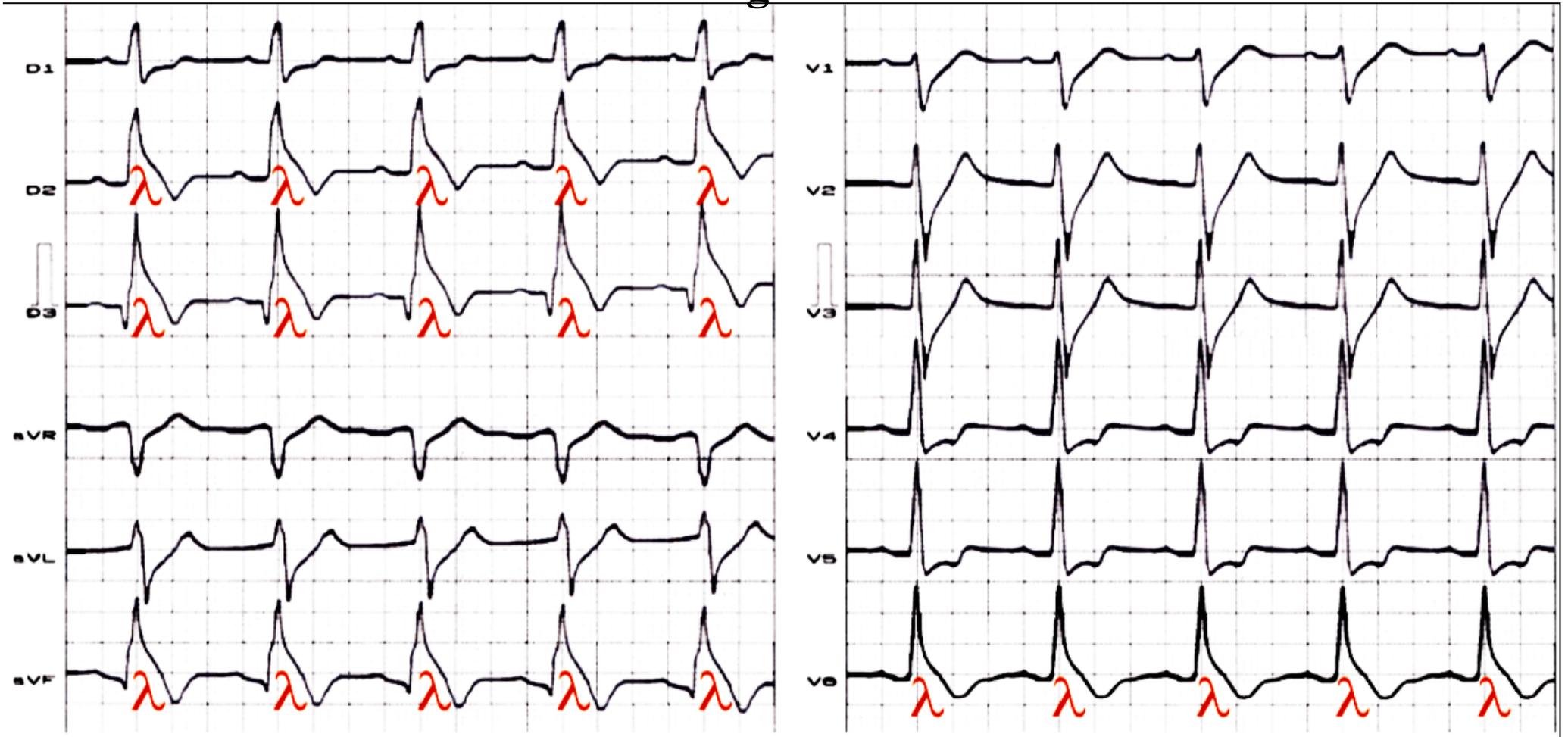
## **The lambda or Gussak wave( $\lambda$ )**



### **Abnormal ECG-waves: This group is eventually registered in pathological circumstances**

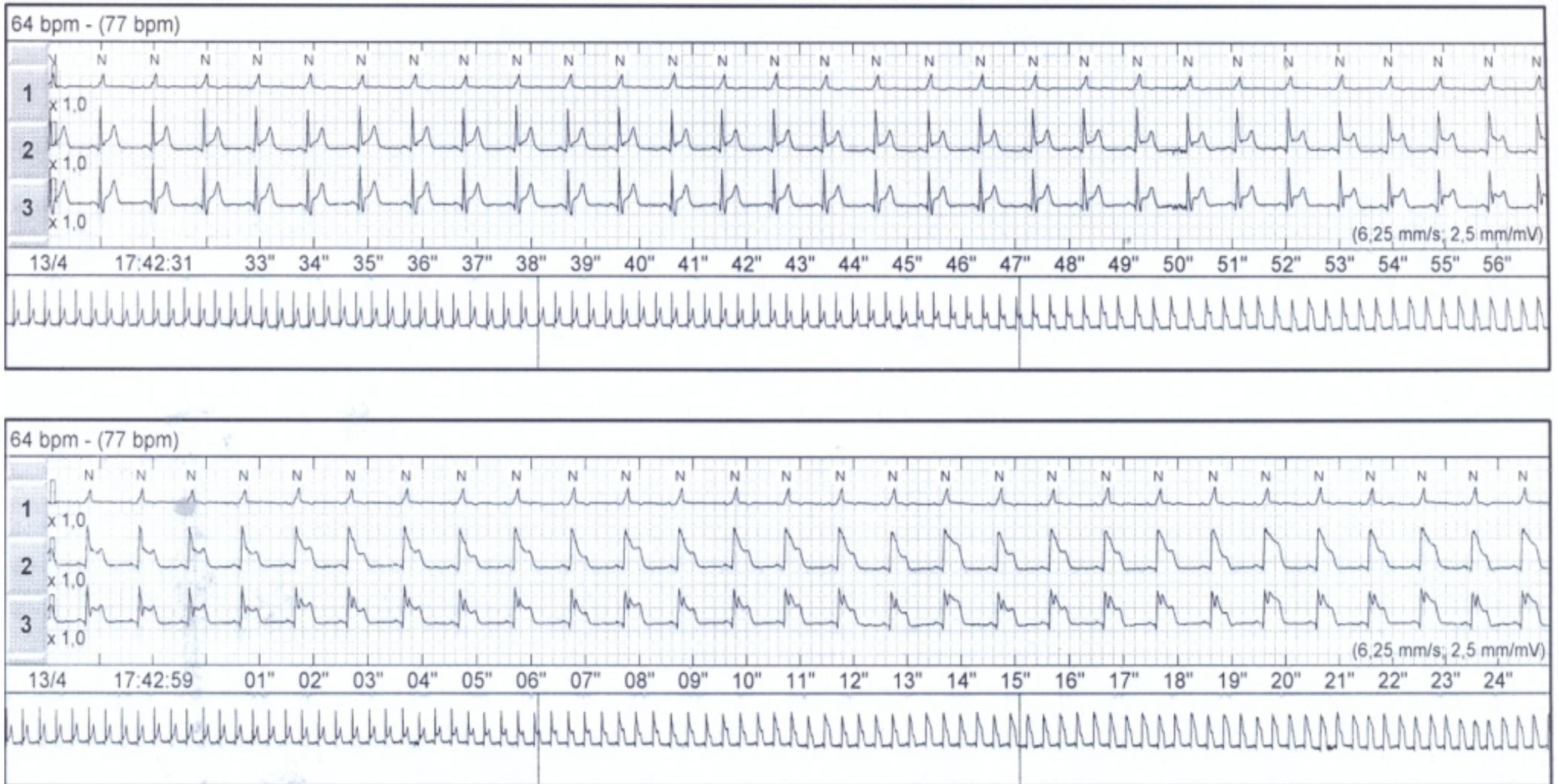
- 1. The Delta( $\delta$ ) wave.** It is caused by preexcitation of the ventricles via a congenital bypass tract. The pre-excitation pattern is caused by an extra connection between the atria and the ventricles (accessory bundle) that forms an electrical bypass to the AV node.
- 2. The J wave,(13) also referred to as the J deflection, "the camel's hump"/ camel-hump sign (14), "late delta wave", elevated J-point(15), hathook junction, hypothermic wave, prominent J wave, K wave, H wave, current of injury or Osborn wave.(16)**
  - Hypothermal or cool wave(17)
  - Normothermal
- 3. The epsilon( $\epsilon$ ) wave, right precordial epsilon potentials or Fontaine wave:** Its wave constitute a mayor criteria for the diagnosis of arrhythmogenic right ventricular cardiomyopathy/dysplasia (ARVC/D).(18)
- 4. The lambda or Gussak wave( $\lambda$ ). (6): this wave was observed in two clinical context:**
  - **Sub-type IC of atypical Brugada ECG pattern or idiopathic ventricular fibillation: ST-segment elevation is triangular or coved to the top ("coved type")  $\geq 2\text{mm}$  (0.2mV), and followed by negative T wave located in inferior or inferoapical leads.(see next slide Figure 6)**
  - **In the context of acute coronary syndrome or in Prinzmetal angina/variant angina: Figures 7 to 9.**

## Figure 6



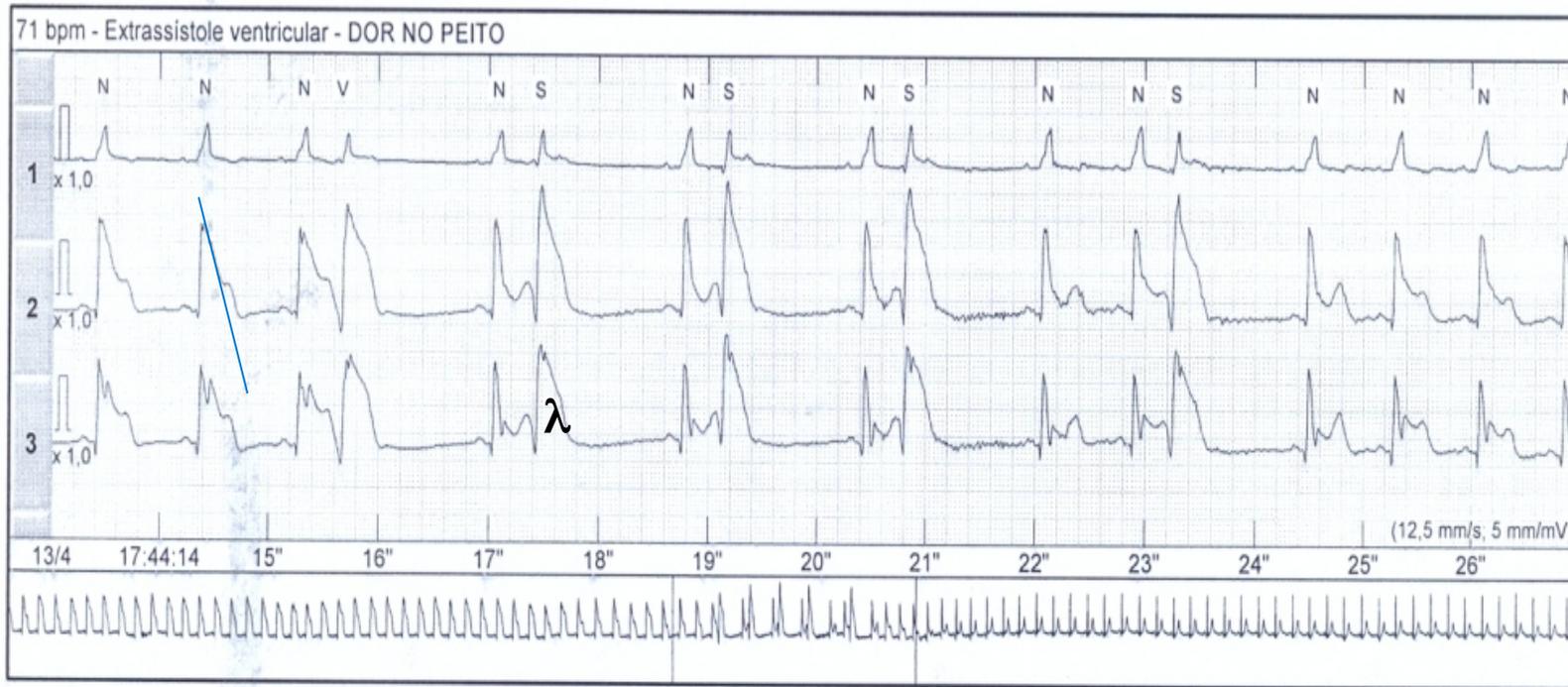
The patient was a young symptomatic (repetitive syncope episodes) Thai man, with positive familial background of SCD in young first degree relatives. He died 24h after performing this ECG. The ECG shows persistent ST segment elevation in the inferior and low lateral precordial apical leads (V5-V6), associated with concomitant reciprocal or mirror image in the anteroseptal wall that was not modified with the use of sublingual nitrate in absence of hypothermia, electrolyte imbalance or ischemia.

# Figure 7



**Man who had coronary revascularization a time ago. Continuous Holter monitoring during an episode of angina and concomitant ST segment elevation and ischemic giant J-wave "lambda-like type" associated with Premature Ventricular Contractions with Bigeminy sequence and very short coupling. The PVCs disappear immediately after cessation of vasospastic ischemia with administration of sublingual nitrate.**

**Figure 8**



**With chest pain/PVCs bigeminism      Pain relief with  
sublingual nitrate      ALÍVIO DA DOR APÓS NITRATO SL**

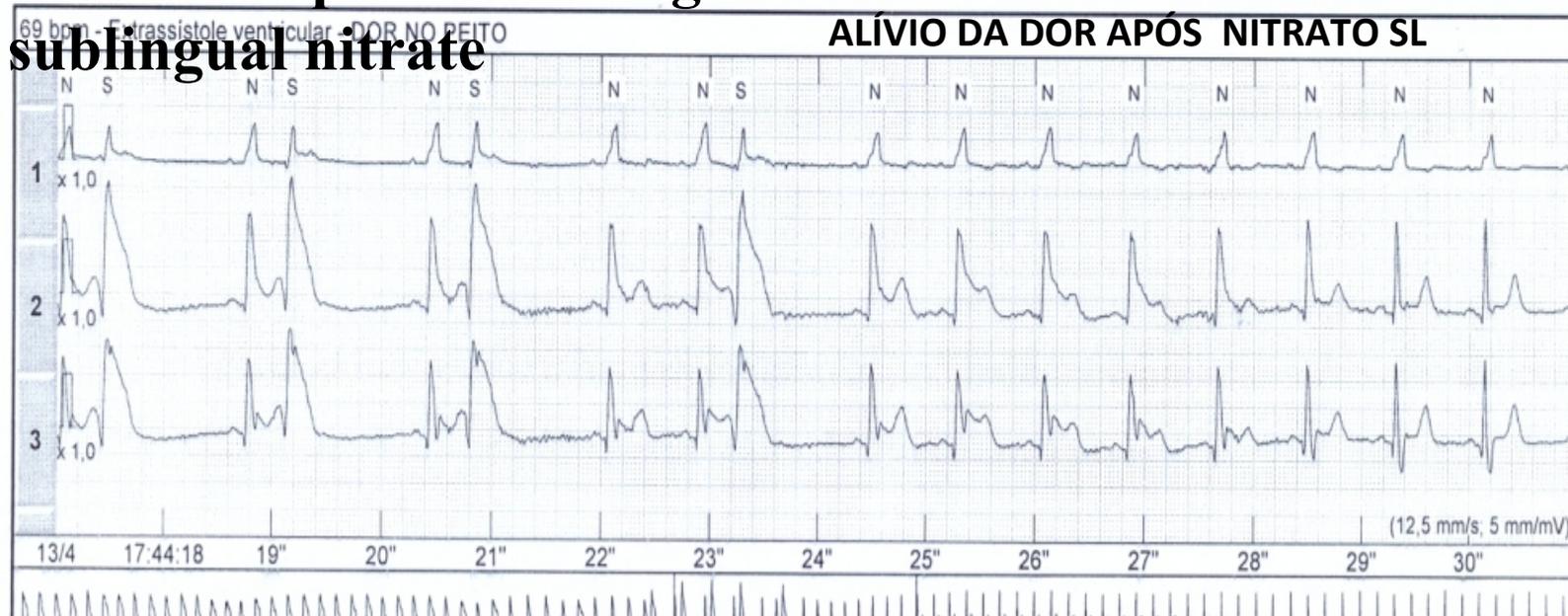
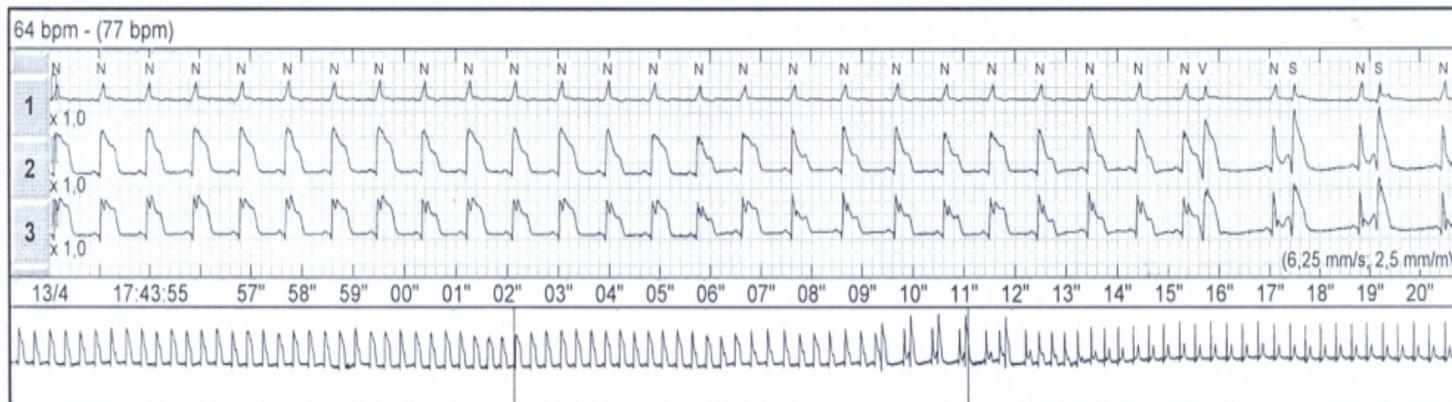
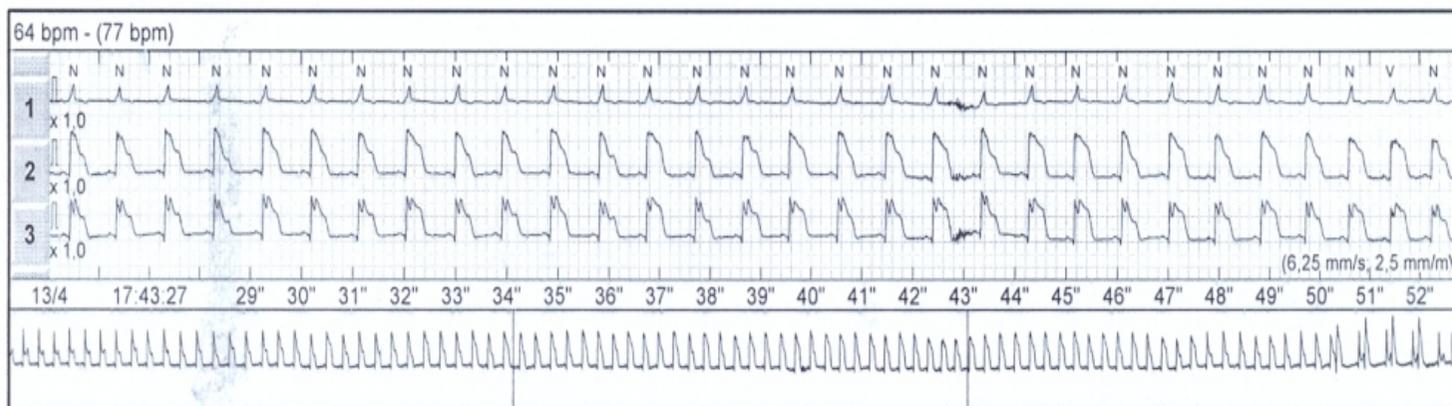
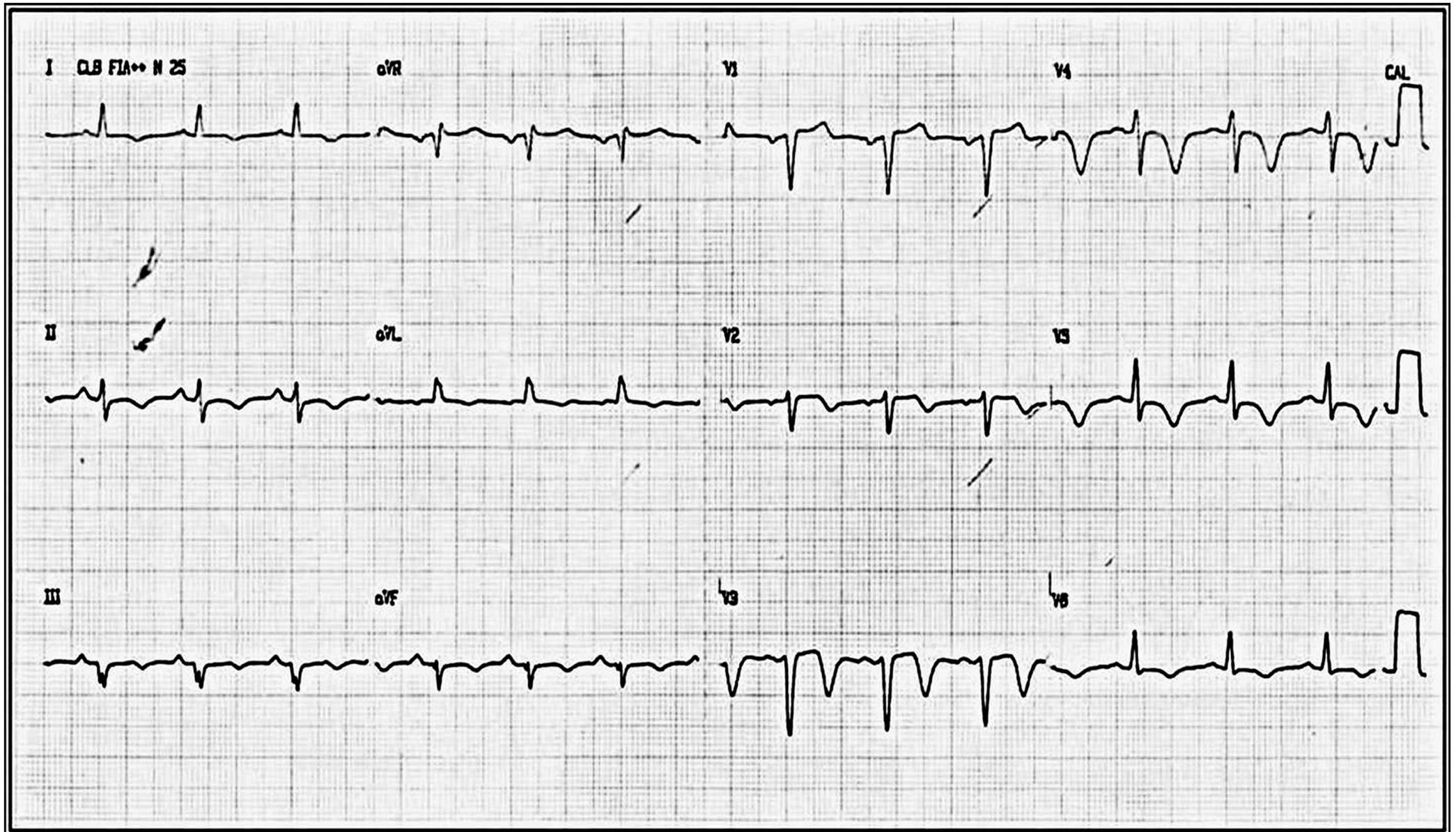


Figure 9

Continued registration of Holter / CONTINUAÇÃO DO TRAÇADO

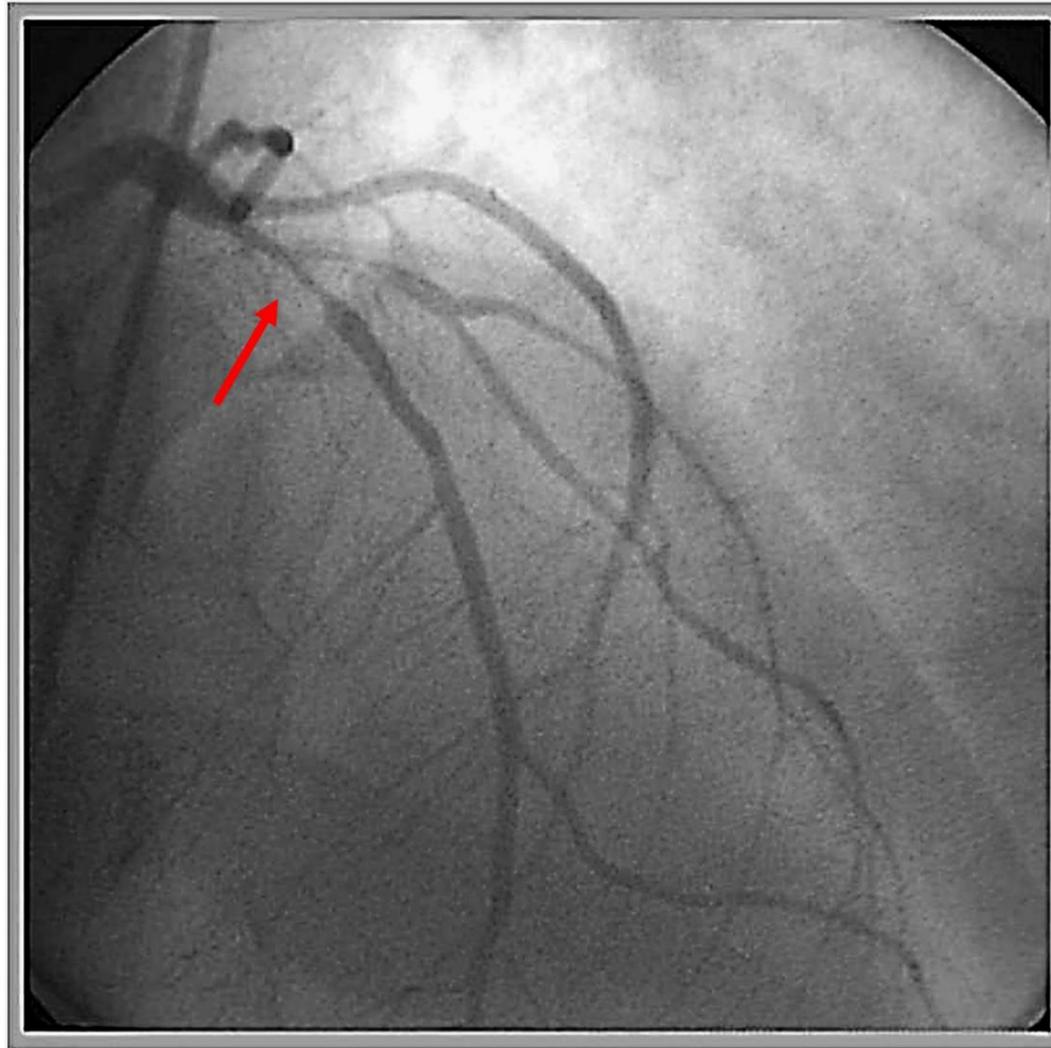


**Figure 10 –ECG-2 after administration of streptokinase**



**Figure 10 shows ST segment resolution and early T wave inversion after the administration of streptokinase. Such behavior is compatible with full myocardial reperfusion (Sclarovsky).**

**Figure 11**



**Figure 11 shows the coronary angiography after chemical thrombolysis reveals the anterior descending artery (TIMI III flow) with residual**

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