ACUTE INFERIOR MYOCARDIAL INFARCTION (STEMI): EVOLUTION TO PROMINENT ANTERIOR FORCES

INFARTO AGUDO INFERIOR COM ELEVAÇÃO DO SEGMENTO ST: EVOLUÇÃO COM FORÇAS ANTERIORES PROEMINENTES

Case of Dr Raimundo Barbosa Barros MD Fortaleza Ceará Brazil

Professor Andrés, Qual a explicação para esta evolução eletrocardiografica.
Homem de 50anos com infarto agudo do miocárdio com elevação do segmento ST **(STEMI):** submetido à ATC primária com stent.
ECG1: antes do cateterismo. Qual seria a artéria culpada?
ECG2: póst cateterismo. O que sugere esta evolução?
ECG3 and ECG 4 no quarto dia de evolução do infarto agudo aparecem forças anteriores proeminentes.

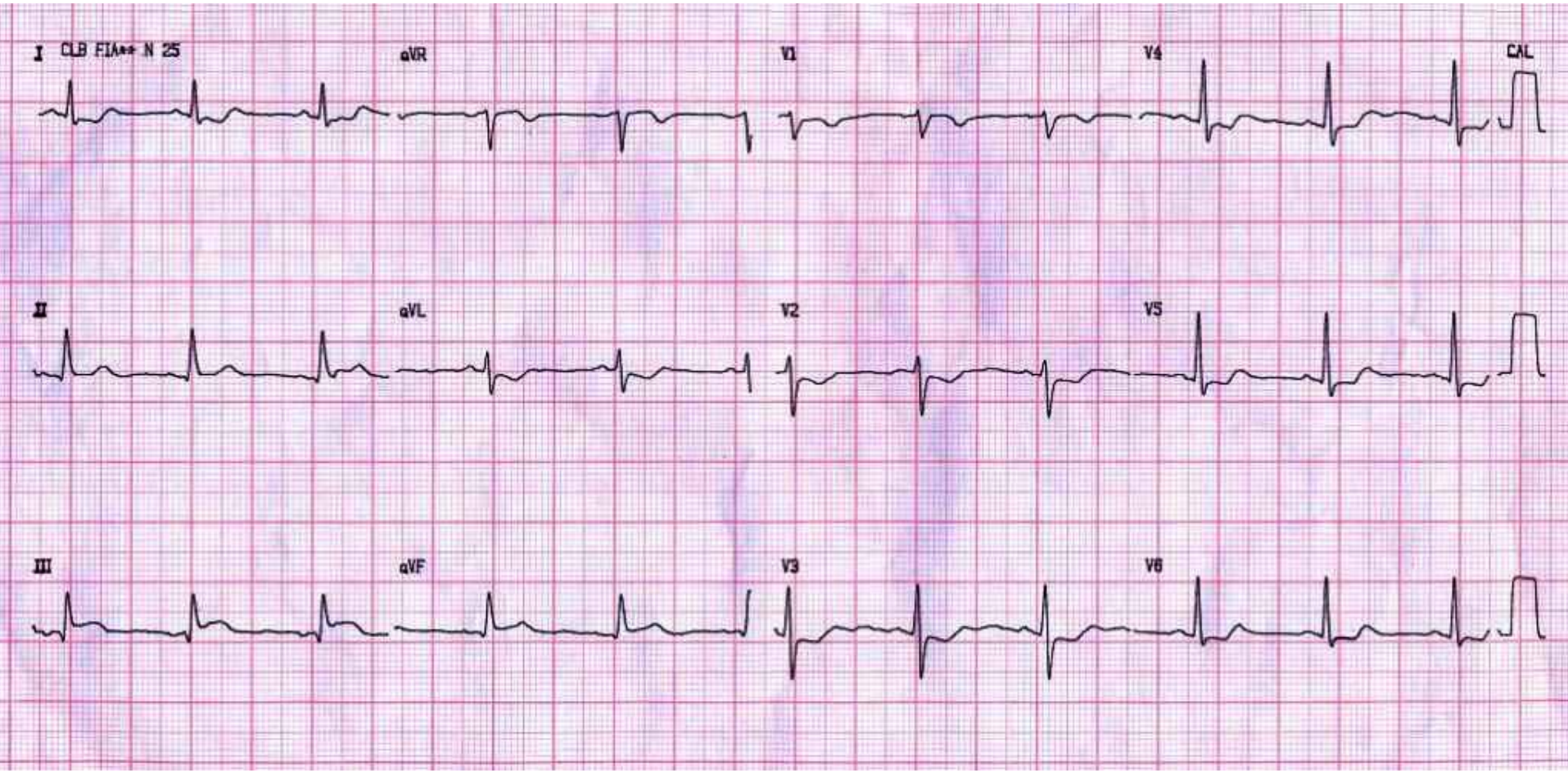
Coronariografia: mencionaremos os dados após a discusão

Raimundo Barbosa Barros MD

Professor Andrés , What is the explanation for the evolves electrocardiographic.
Man 50 yo with acute myocardial infarction (STEMI): underwent primary PTCA with coronary stent implantation.
ECG1 before CATE Which is the culprit artery?
ECG2 after catheterization What suggest this evolution?
ECG3 and ECG 4 both preformed on the fourth day. Prominent Anterior Forces
Coronary angiography: mention the data after the discussion about it

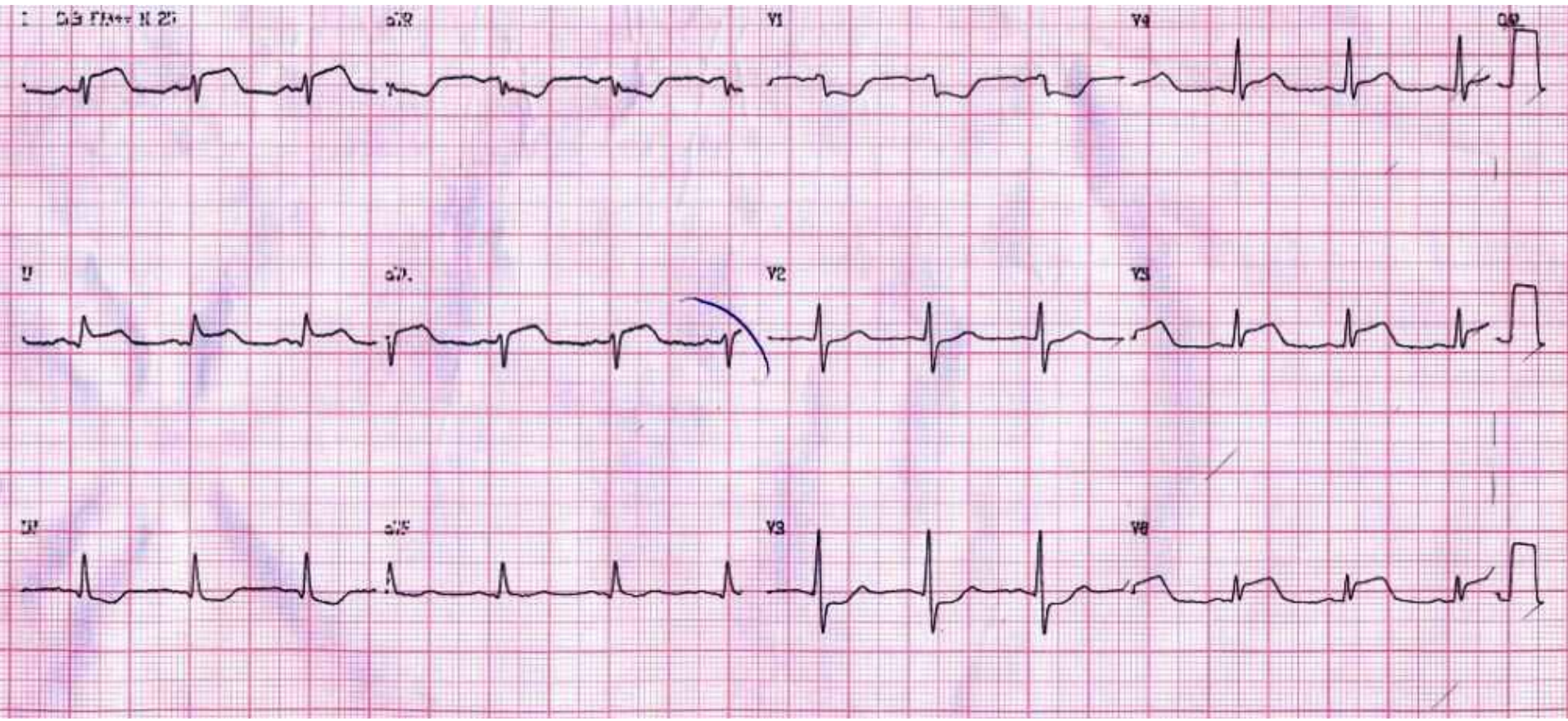
Raimundo Barbosa Barros MD

ECG 1: before primary PTCA procedure

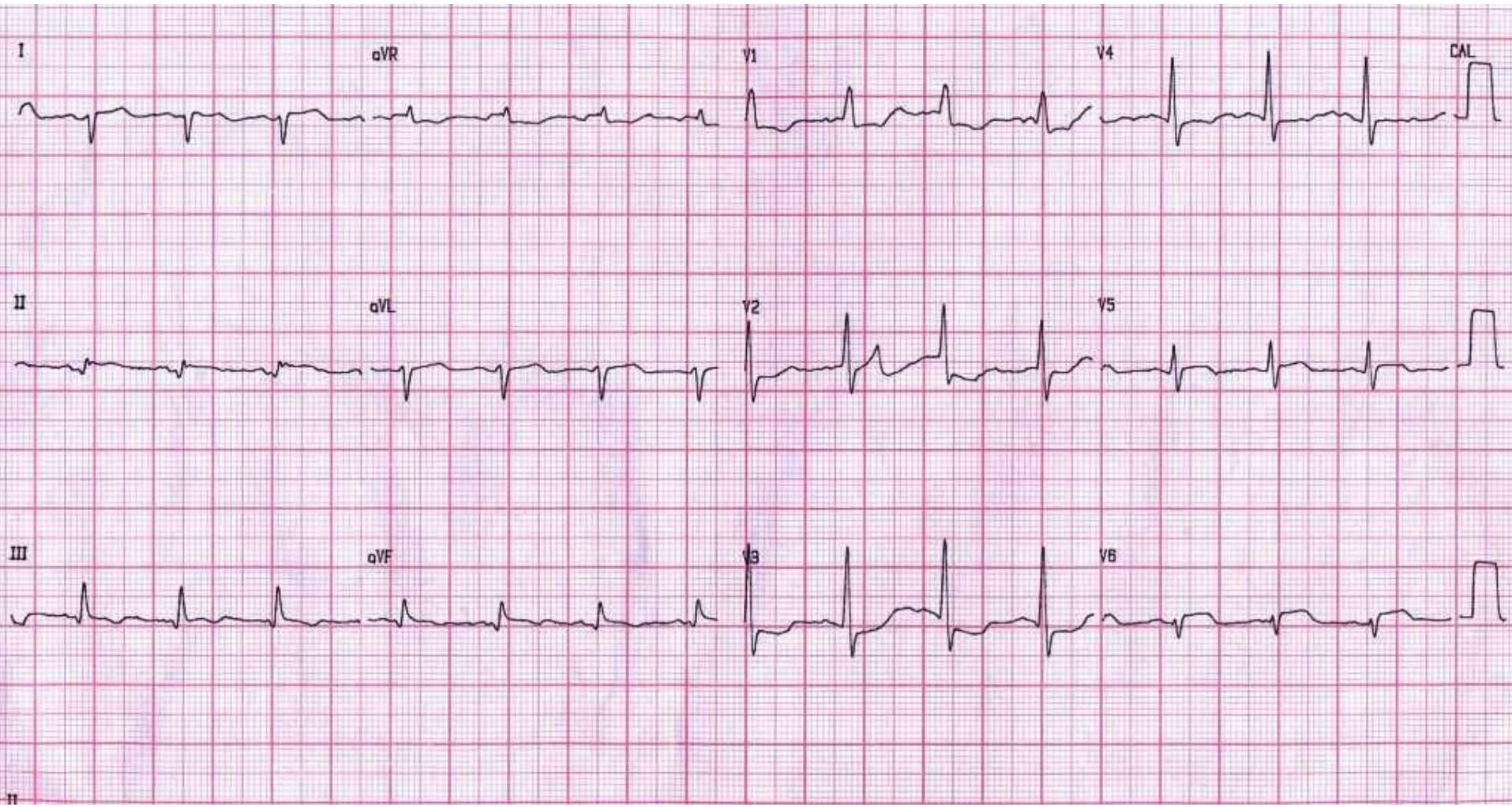


ECG 2: immediately after procedure

ECG2: imediatamente antes do procedimento

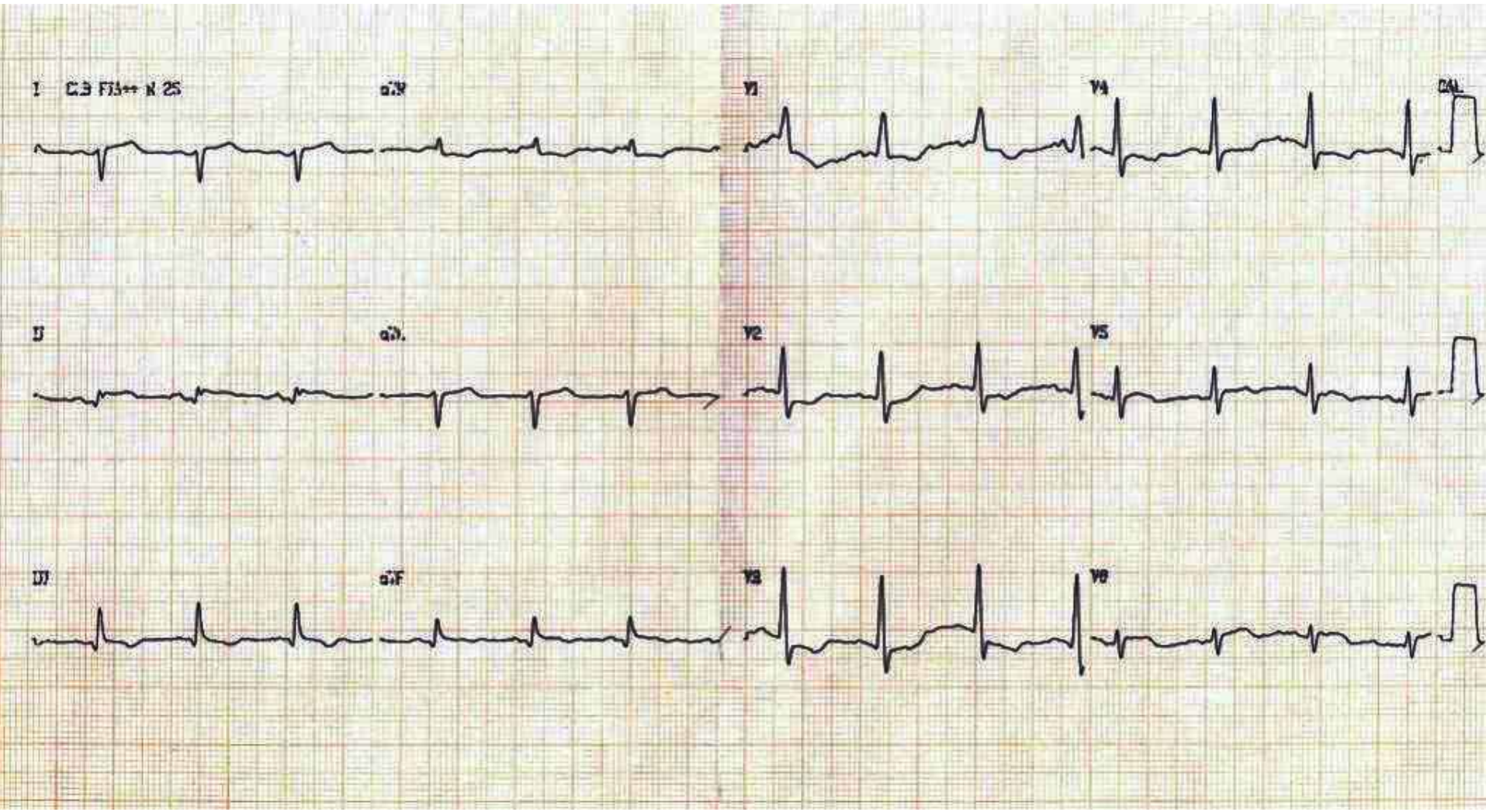


ECG 3: Four day later .... ECG 3: Quatro dias mais tarde



ECG 4: also preformed on the fourth day.

ECG 4: Também realizado no quarto dia



COLLEAGES OPINIONS
OPINIÃO DOS COLEGAS

El ECG1 me impresiona como un evento isquémico hiperagudo por compromiso proximal de una artéria circunfleja dominante que en la evolución afectó de segmento posterolateral, y al cuarto dia ocasionó necrosis de dichos segmentos lo que explica el aumento de fuerzas anteriores en plano horizontal (R en V1 Rs V2) y la desviación de eje eléctrico del QRS para la derecha en plano frontal con giro horário imitando un bloqueo posteroinferior (patron S1-q3 -T3).
Posiblemente el cateterismo muestre oclusión de la porción poximal de la artéria circunfeja
La ATC no fue exitosa (desearia saber cuantas horas pasaron desde el inicio del cuadro hasta la colocación del stent?
Posiblemente el procedimiento fue realizado tardiamente, fuera de la ventana de tiempo?

Afectuosamente
Juan Jose Sirena MD Santiago del Estero- Argentina

The ECG1 hyperacute ischemic event consequence of proximal obstruction of left dominant circumflex coronary artery (LCx), that in its evolution affects posterolateral wal segment, and at the fourth day left necrosis of these segments which explains the increase of anterior QRS forces in horizontal plane (R in V_1 and Rs V2) associated with QRS deviation axis to right with CCW rotation in the frontal plane imitating left posterior fascicula block (S1-Q3-T3 pattern).
Possibly, the catheterism will show occlusive on poximal LCx. The primary ATC was not successful (I would like to know how many hours have passed since the the picture beginning until the placement of the stent?
Possibly the procedure was performed late, outside the window of time?
Affectionately
Juan José Sirena MD

FINAL CONCLUSION

CONCLUSÕES FINAIS

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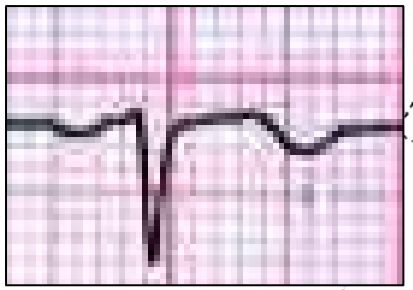
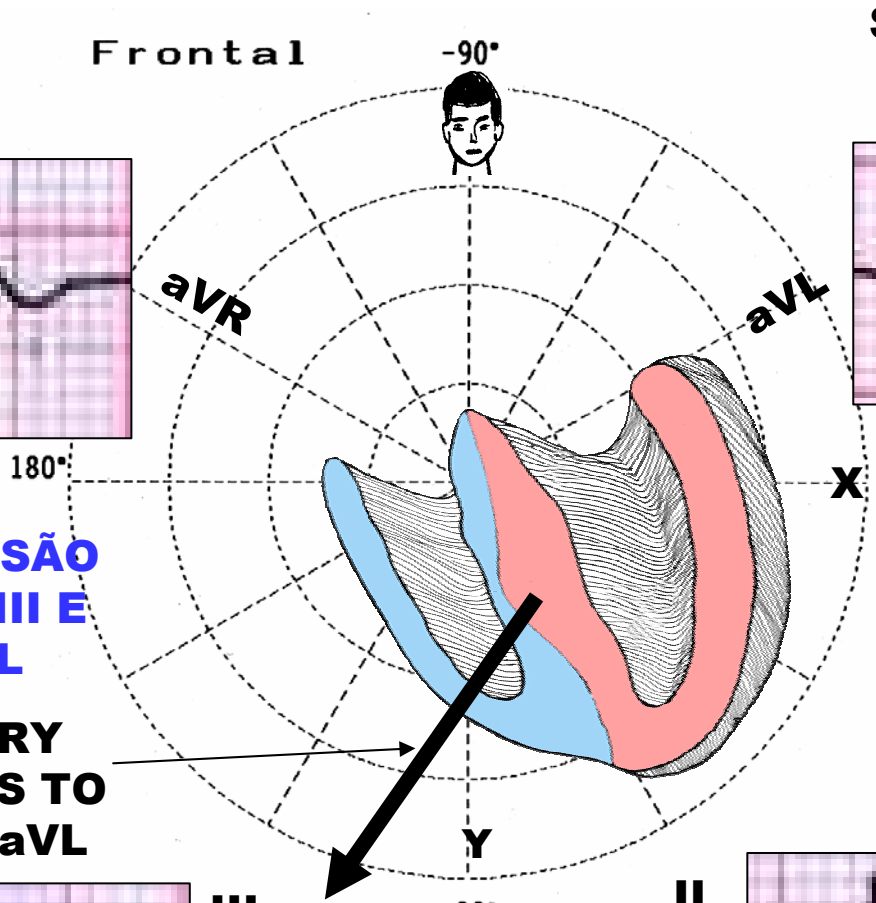
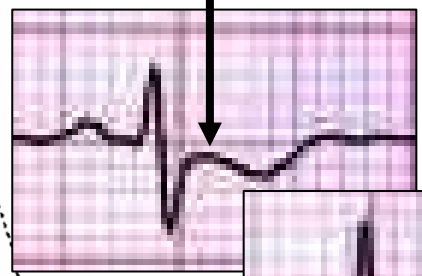
ACUTE INFERIOR ST-SEGMENT ELEVATION MYOCARDIAL INFARCTION (iSTEMI)

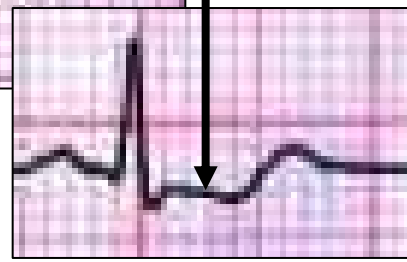
ECG 1





ST depression aVL and I





I

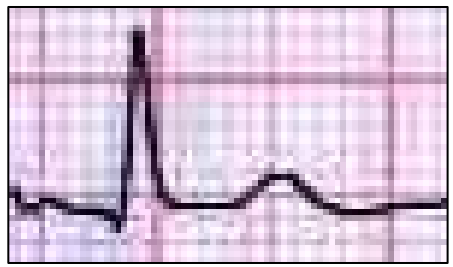
O VETOR DE LESÃO APONTA PARA III E FOGE DE aVL

THE ST INJURY VECTOR POINTS TO III AND FLEES aVL

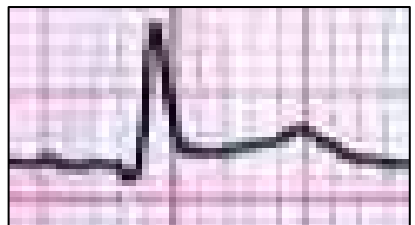
QRS axis +95º

III

II



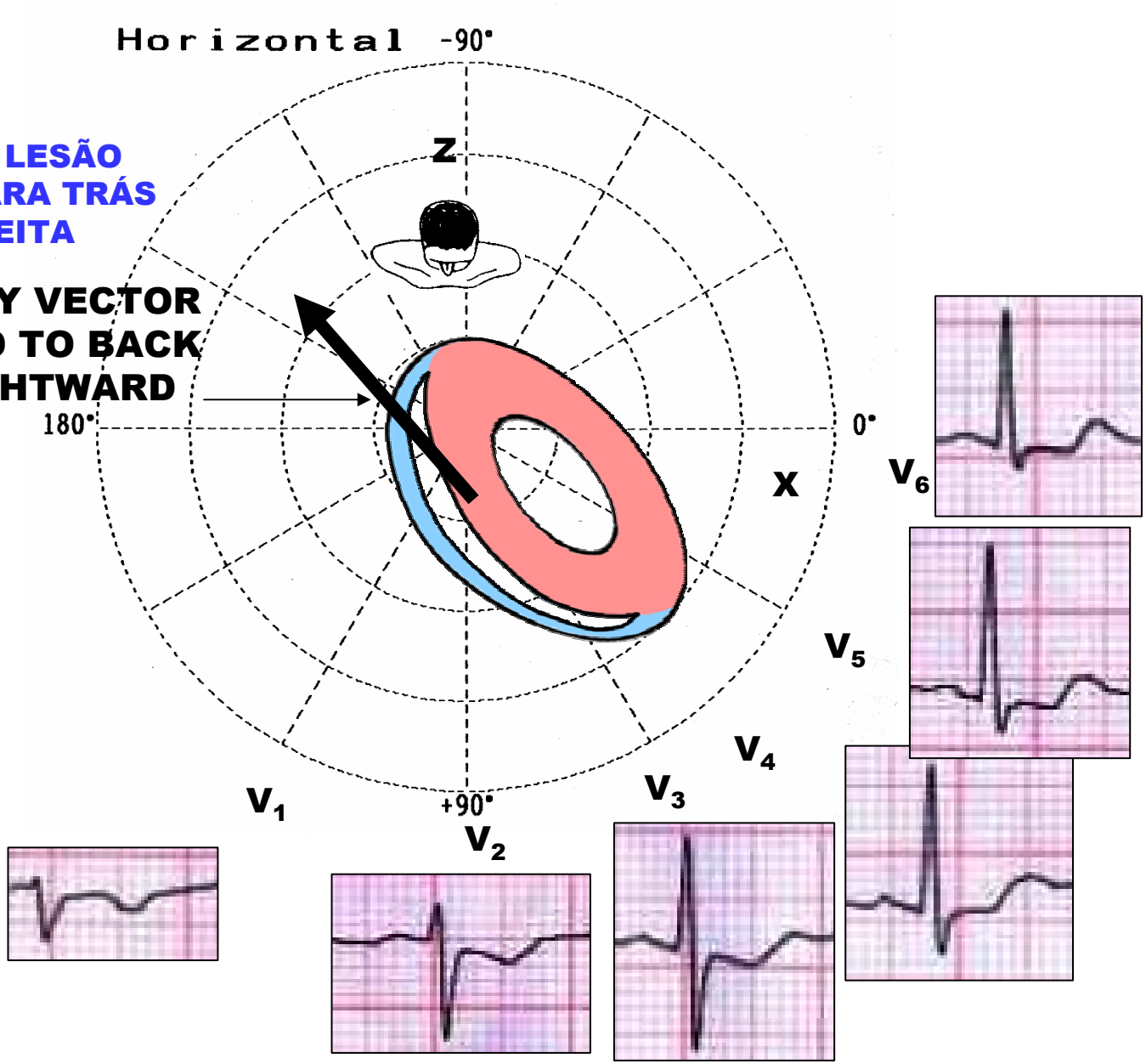
ST III elevation > SIII



ECG 1

VETOR DE LESÃO DIRIGIDO PARA TRÁS E A DIREITA

ST INJURY VECTOR DIRECTED TO BACK AND RIGHTWARD



ST DEPRESSION ACROSS ALL PRECODIAL LEADS. DEPRESSÃO DO ST AO LONGO DE TODAS AS PRECORDIAIS

FIRST IMPRESION:
PROXIMAL OCCLUSION RCA

LITERATURE CRITERIA

1. ST-segment depression in lead V_1
2. ST-segment depression in leads V_1-V_3 : specificity (77.2%)positive predictive value (56.5%),
3. Maximum ST-segment depression in the precordial leads
4. ST-segment depression in lead V_3 or ≤ 50% of the magnitude of ST-elevation in lead III
5. Absence of ST-segment depression in lead V_1 in combination with ST-segment depression in lead V_2
6. The arithmetic sum of the ST-segment elevation in V_3 / ST-elevation in III <0.5 had the highest sensitivity (80.9%) and negative predictive value (86.7%)[1].
7. Greater ST elevation in lead III than in II, greater ST depression in aVL than I, and a R/S ratio of greater than 1:3 in aVL are not useful to discriminate between dominant RCA and dominant LCx occlusion-related inferior AMI[2].
8. ST-segment deviation in lead V_4R and the ratio of ST downward V3/ST upward III are useful in predicting the dominant artery occlusion-related inferior AMI.
9. In patients with Interatrial block at rest who have CAD, the RCA is predominantly more significantly affected[3].

1. **Styliadis I, Ziakas A, Karvounis H, et al. The utility of the standard 12-lead electrocardiogram in the prediction of proximal right coronary artery occlusion in acute inferior myocardial infarction. J Emerg Med. 2008 Jul;35:67-72.**
2. **Zhan ZQ, Wang W, Dang SY, et al. Electrocardiographic characteristics in angiographically documented occlusion of the dominant left circumflex artery with acute inferior myocardial infarction: limitations of ST elevation III/II ratio and ST deviation in lateral limb leads. J Electrocardiol. 2009 Sep-Oct;42:432-439.**
3. **Ariyarajah V, Fernandes J, Apiyasawat S, Spodick DH. Angiographic localization of potential culprit coronary arteries in patients with interatrial block following a positive exercise tolerance test. Am J Cardiol. 2007 Jan 1;99:58-61.**

PRIMEIRA IMPRESSÃO: OBSTRUÇÃO DA CORONÁRIA DIREITA
CRITÉRIOS RELATADOS PELA LITERATURA

1. *Depressão do ST em V1*
2. *Depressão do segmento S de V1-V3 : especificidade de 77.2% e valor preditivo positivo de 56.5%,*
3. *Depressão máxima do ST nas precordiais*
4. *Depressão do ST em V3 ou ≤ 50% da magnitude da elevação do ST em III*
5. *Ausência de depressão do ST em V1 associado com depressão do ST em V2*
6. *A soma aritmética da elevação do ST em V3 / elevação do ST em III <0.5 possui alta sensibilidade (80.9%) e valor preditivo negativo de (86.7%)1.*
7. *Maior elevação do segmento ST em III que II, maior depressão do ST aVL que I, e uma relação R/S > 1:3 em aVL não discrimina entre obstrução da coronária direita dominante e circunflexa dominante em caso de IM inferior AMI[2].*
8. *O desnivelamento do ST em V4R e a relação depressão do ST em V3)/ elevação do ST III é significativa na predição a artéria dominante ocluída em caso de IM inferior.*
9. *Em paciente com bloqueio interatrial no repouso que possuem doença coronariana a artéria coronária direita e mais significativamente afetada [3].*

1. **Styliadis I, Ziakas A, Karvounis H, et al. The utility of the standard 12-lead electrocardiogram in the prediction of proximal right coronary artery occlusion in acute inferior myocardial infarction. J Emerg Med. 2008 Jul;35:67-72.**
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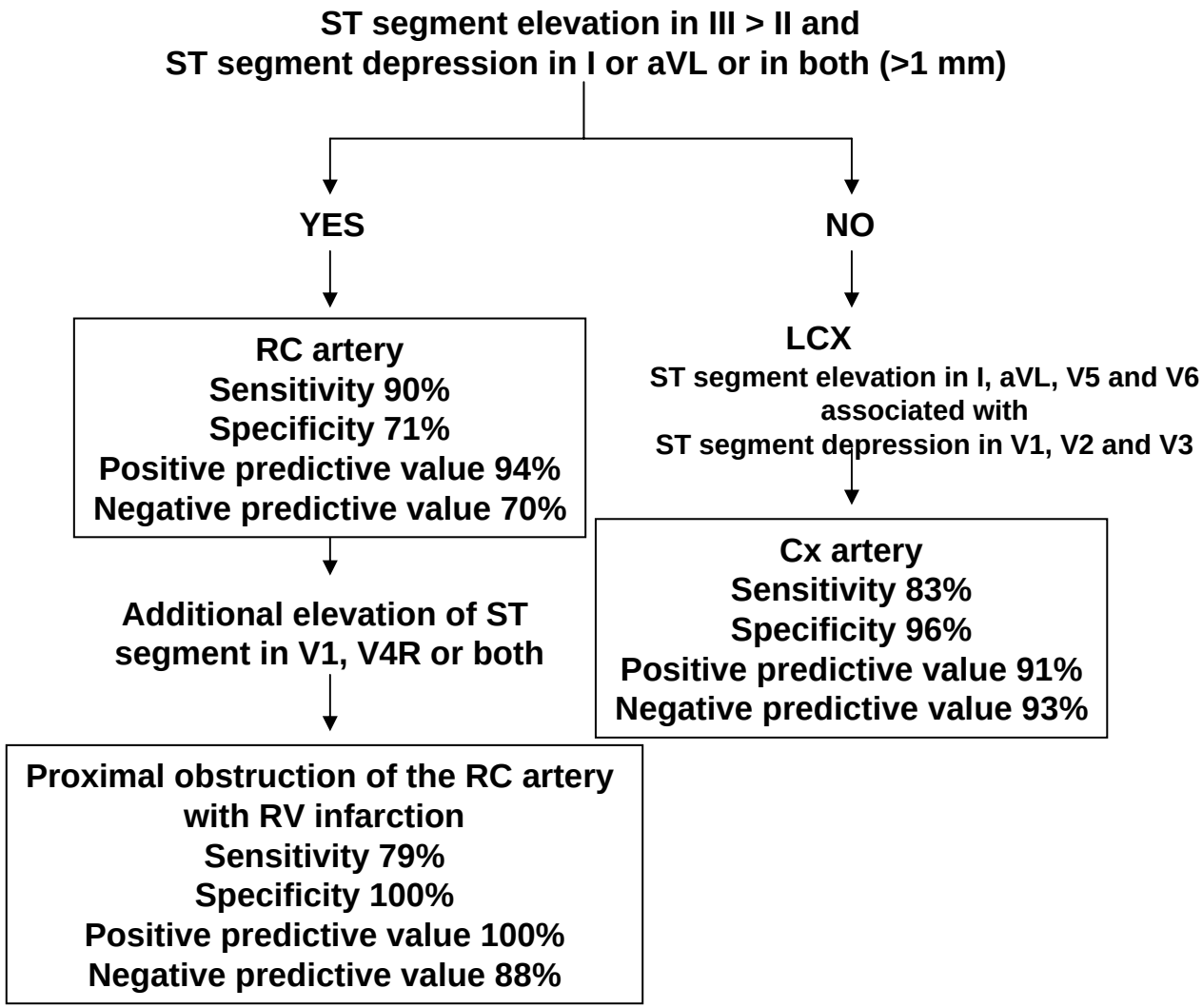
ALGORITHM TO IDENTIFY THE ARTERY INVOLVED WITH INFERIOR INFARCTION BY ECG



Algorithm to identify through ECG the artery involved by inferior infarction.

INFERIOR WALL IRRIGATION BY THE BRANCH OF THE RIGHT CORONARY ARTERY (RCA) AND LEFT CIRCUMFLEX (LCX).

IRRIGAÇÃO DA PAREDE INFERIOR PELAS ARTÉRIAS CORONARIA DIREITA(CD) E CIRCUNFLEXA(Cx)

The RCA provides blood supply to the SA Node by this branch, to the right atrium (RA), part of the left atrium (LA), right ventricle (RV), AV Node, inferior wall and low and basal inferior region of the left ventricle (LV).

The branches of the RC artery that irrigate the inferior wall are:

1) Posterior descending artery (PDA);
2) Left ventricular artery (LV);
3) Posterolateral artery (PL) that originates in the RCA in ≈ 20% of the cases.

The left ventricular branch (LV) originates in the RCA in 80% of the cases and in the LCX in the remaining 20%.

Finally, the posterolateral branch (PL) originates in the LCX in 80% of the cases and RCA in the remaining 20%.

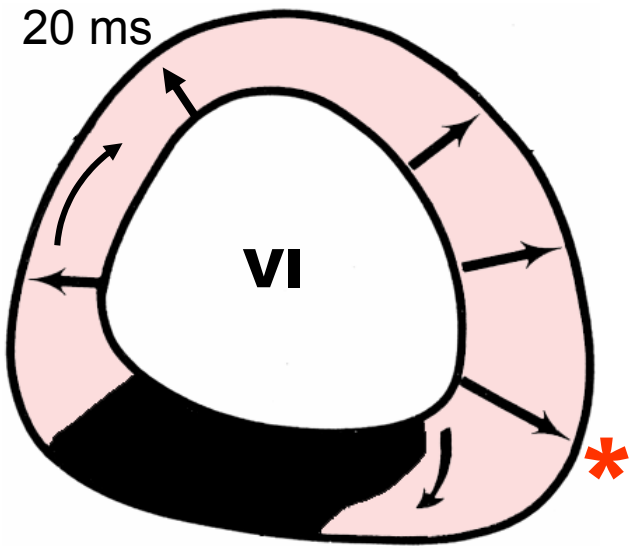
O Nó SA está irrigado pela artéria do Nó SA ramo da CD. A CD também irriga o átrio direito(AD) parte do átrio esquerdo(AE) ventrículo direito(VD) Nó AV, parede inferior e região basal do VE.

Os ramos da CD que irrigam a parede inferior são:

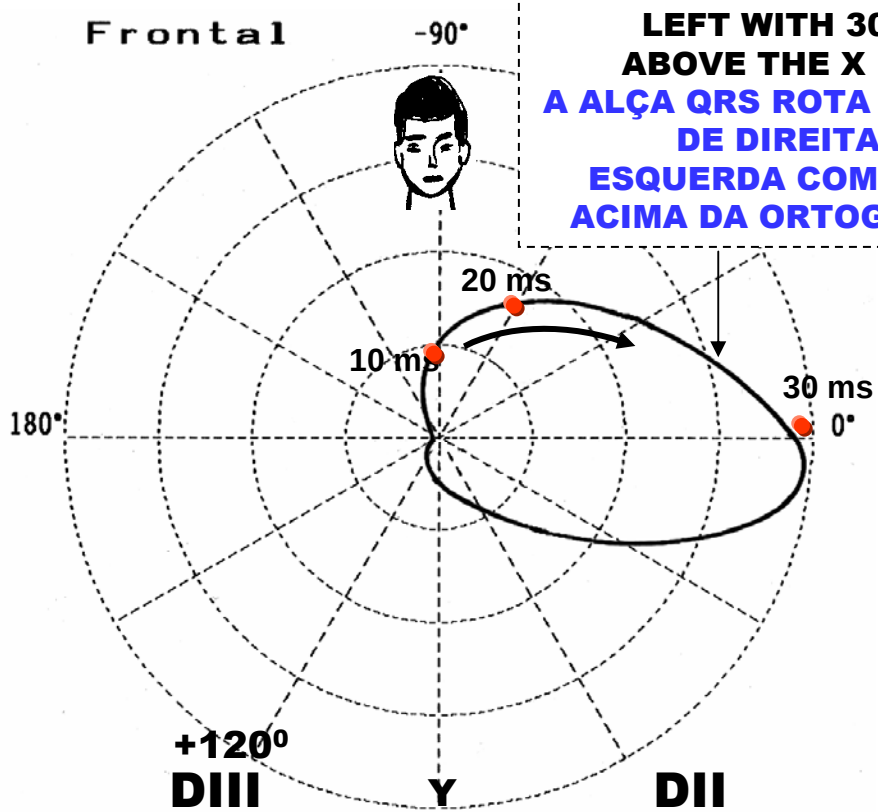
1) Descendente posterior(DP)
2) Artéria do ventrículo esquerdo (VE)
3) Artéria póstero-lateral que se origina da CD em aproximadamente 20% dos casos;
4) O ramo ventricular esquerdo em 80% dos casos origina-se da CD e da Cx nos 20% restantes.

Finalmente p ramo lóstero-latera se origina da Cx em 80% dos casos e da CD no restante 20%.

NON-EXTENSIVE DIAPHRAGMATIC INFARCTION/ INFARTO DIAFRAGMÁTICO NÃO EXTENSO

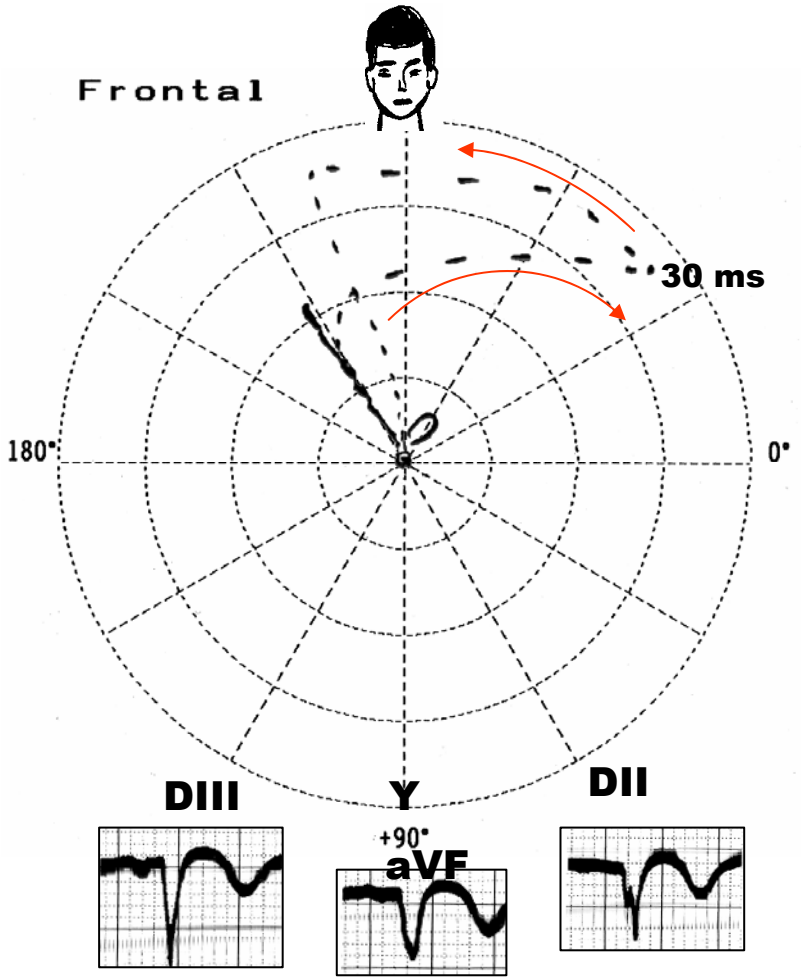


QRS LOOP OF CLOCKWISE ROTATION FROM RIGHT TO LEFT WITH 30 ms ABOVE THE X LINE.
A ALÇA QRS ROTA HORÁRIO DE DIREITA A ESQUERDA COM ≥30ms ACIMA DA ORTOGONAL X

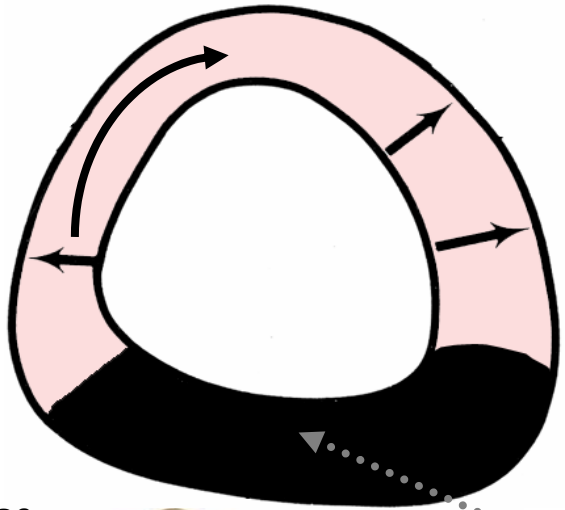


* **THIS VECTOR IS RESPONSIBLE FOR THE FINAL R WAVE IN II, SINCE THE LEFT PART OF THE INFERIOR WALL WAS NOT AFFECTED.**
ESTE VETOR É RESPONSÁVEL PELA R FINAL DE II, PORQUE A PARTE ESQUERDA DA PAREDE INFERIOR NÃO FOI AFETADA

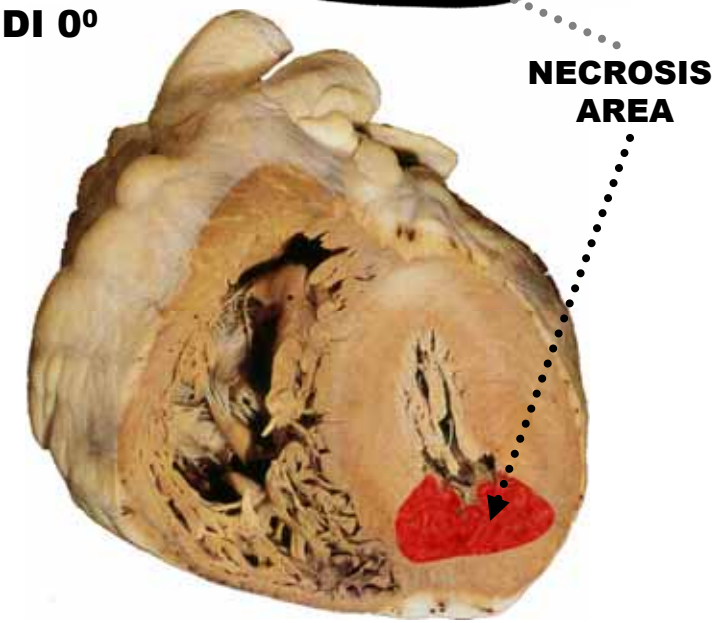
EXTENSIVE DIAPHRAGMATIC INFARCTION/ INFARTO DIAFRAGMÁTICO EXTENSO



QS IN THE THREE INFERIOR LEADS

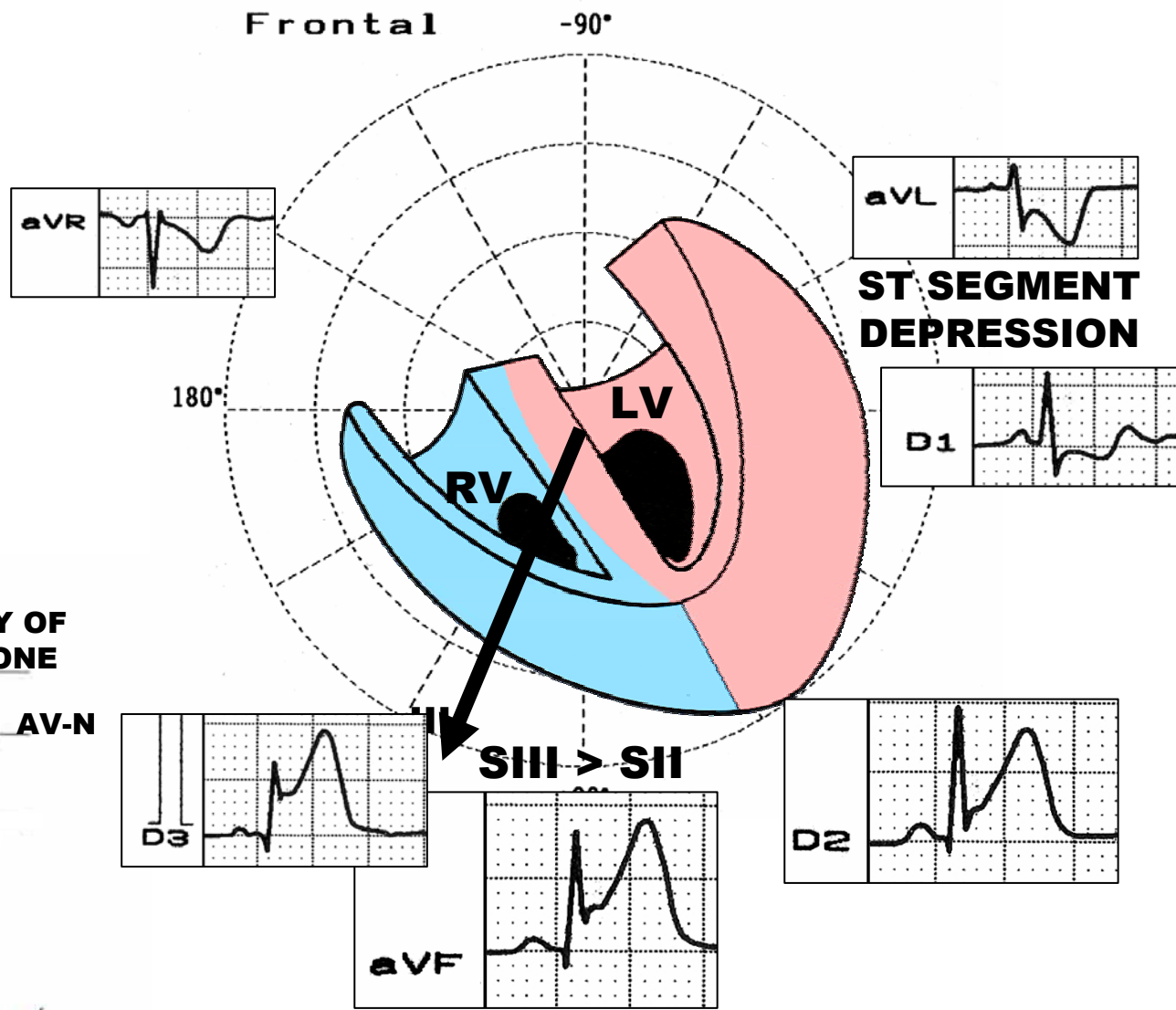


X DI 0º

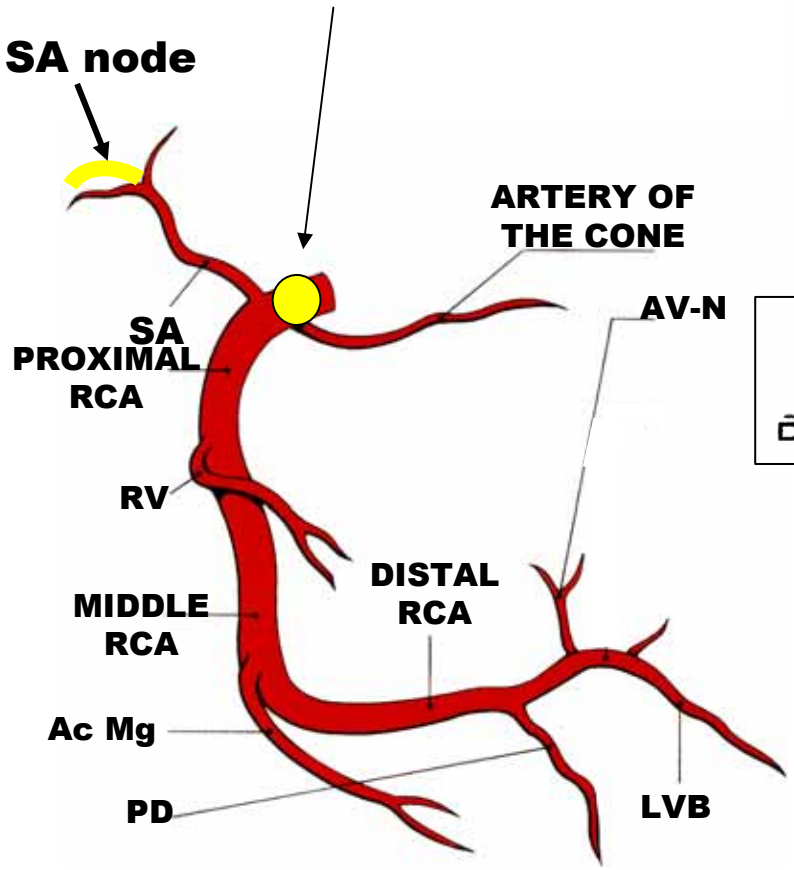


EXTENSIVE INFERIOR INFARCTION THAT INVOLVES ALL THE INFERIOR WALL, WHICH WOULD EXPLAIN THE ABSENCE OF r or R WAVE IN II, III AND aVF.

In AMI, it is of great value to identify the infarct-related artery and the site of occlusion in a coronary artery (proximal versus middle-distal).

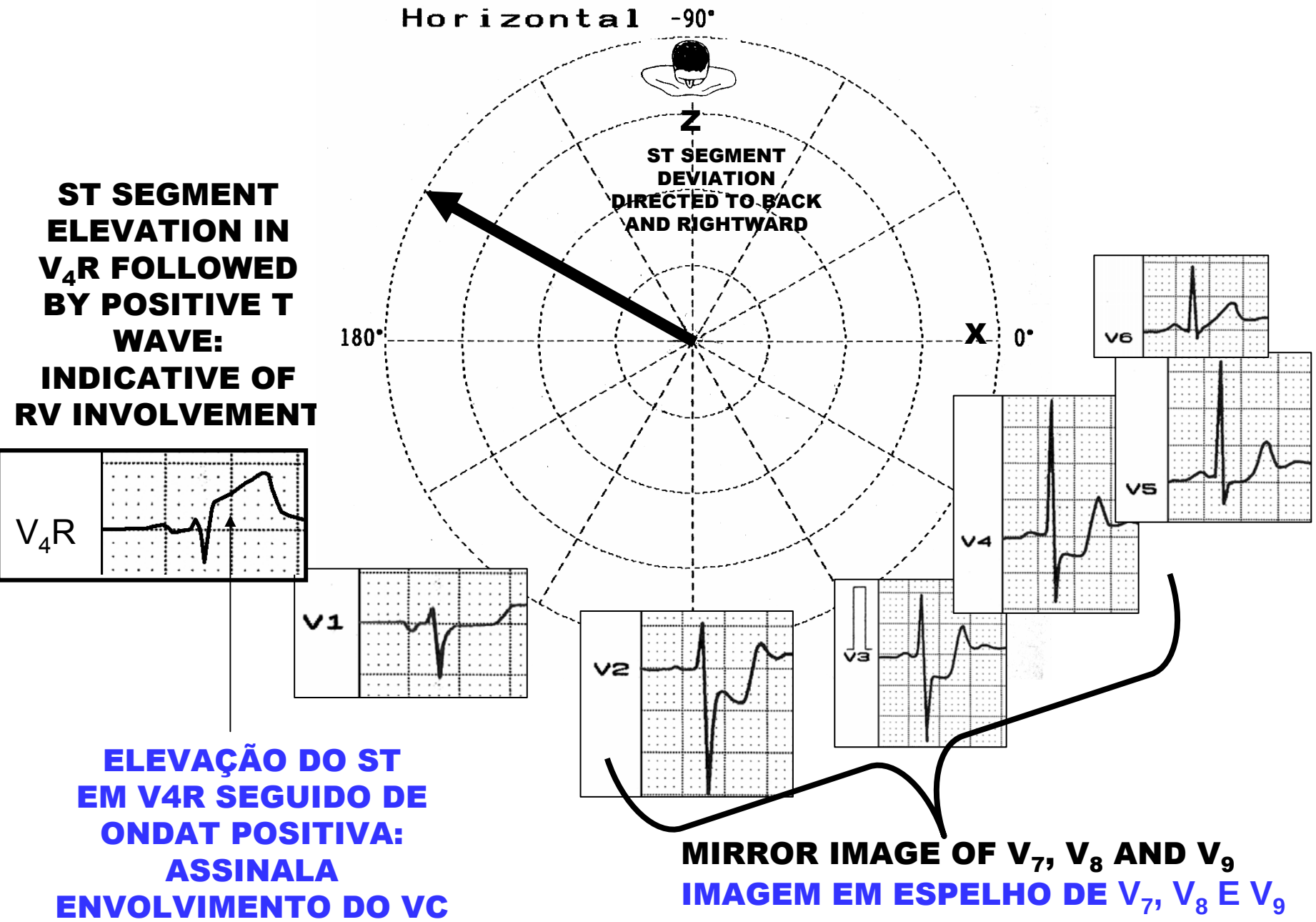


OCCLUSION LOCATION



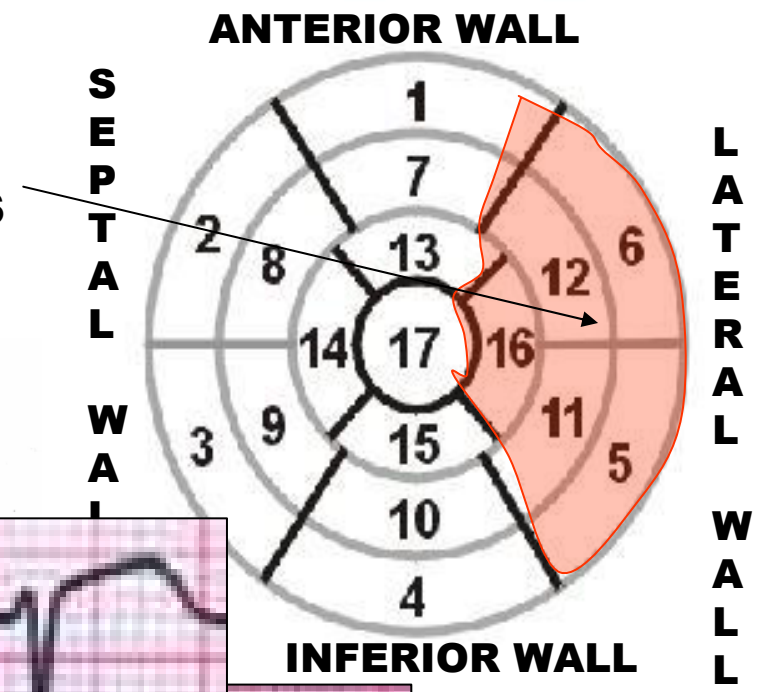
ST SEGMENT ELEVATION IN INFERIOR LEADS SIII>SII BECAUS THE ST INJURY VECTOR POINT TO 120°

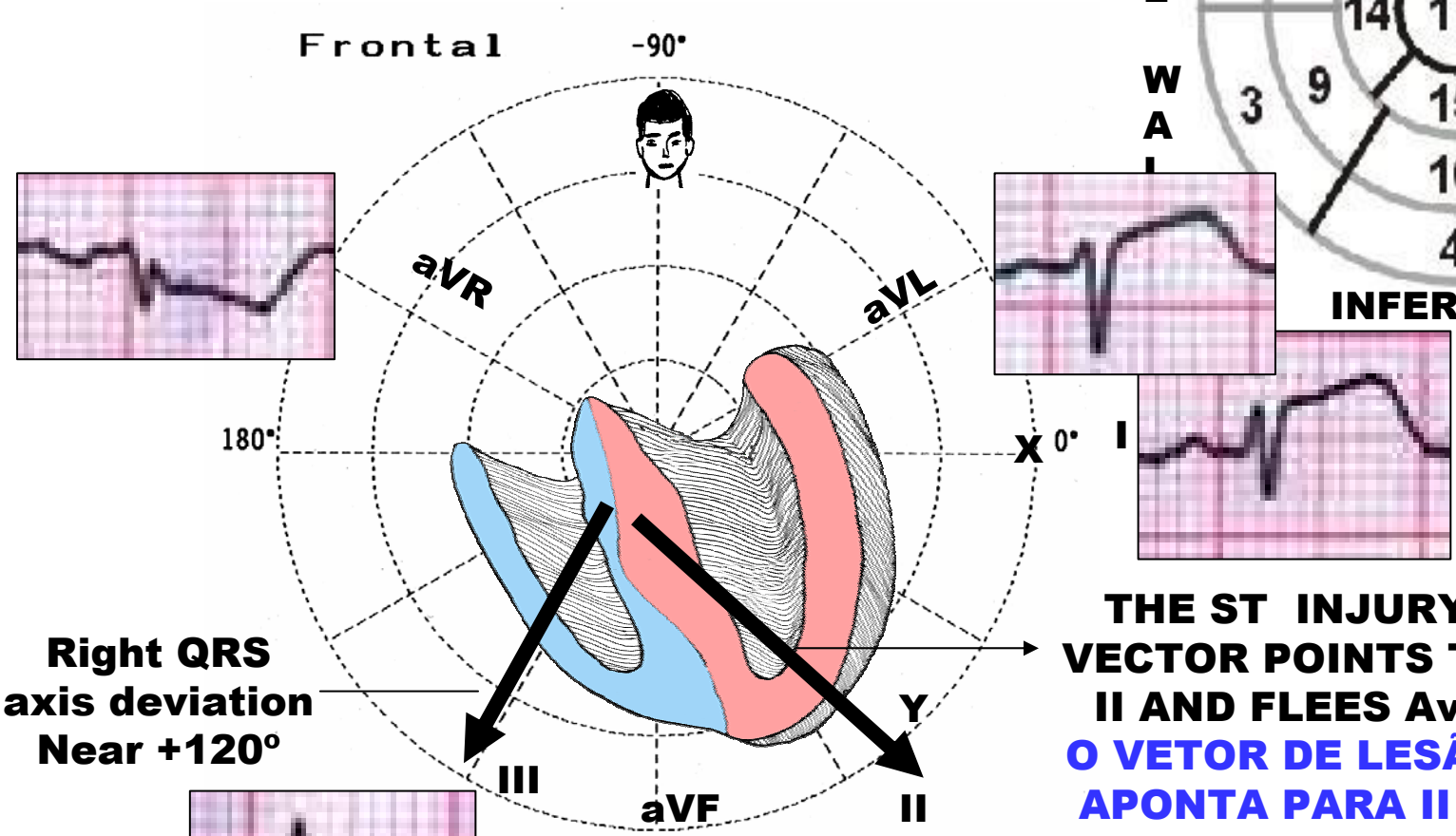
In AMI, it is of great value to identify the infarct-related artery and the site of occlusion in a coronary artery (proximal versus middle-distal).



ECG 2

EMERGENCY CARDIAC CATHETERIZATION
DEMONSTRATE LATERAL WALL HYPOKINESIS

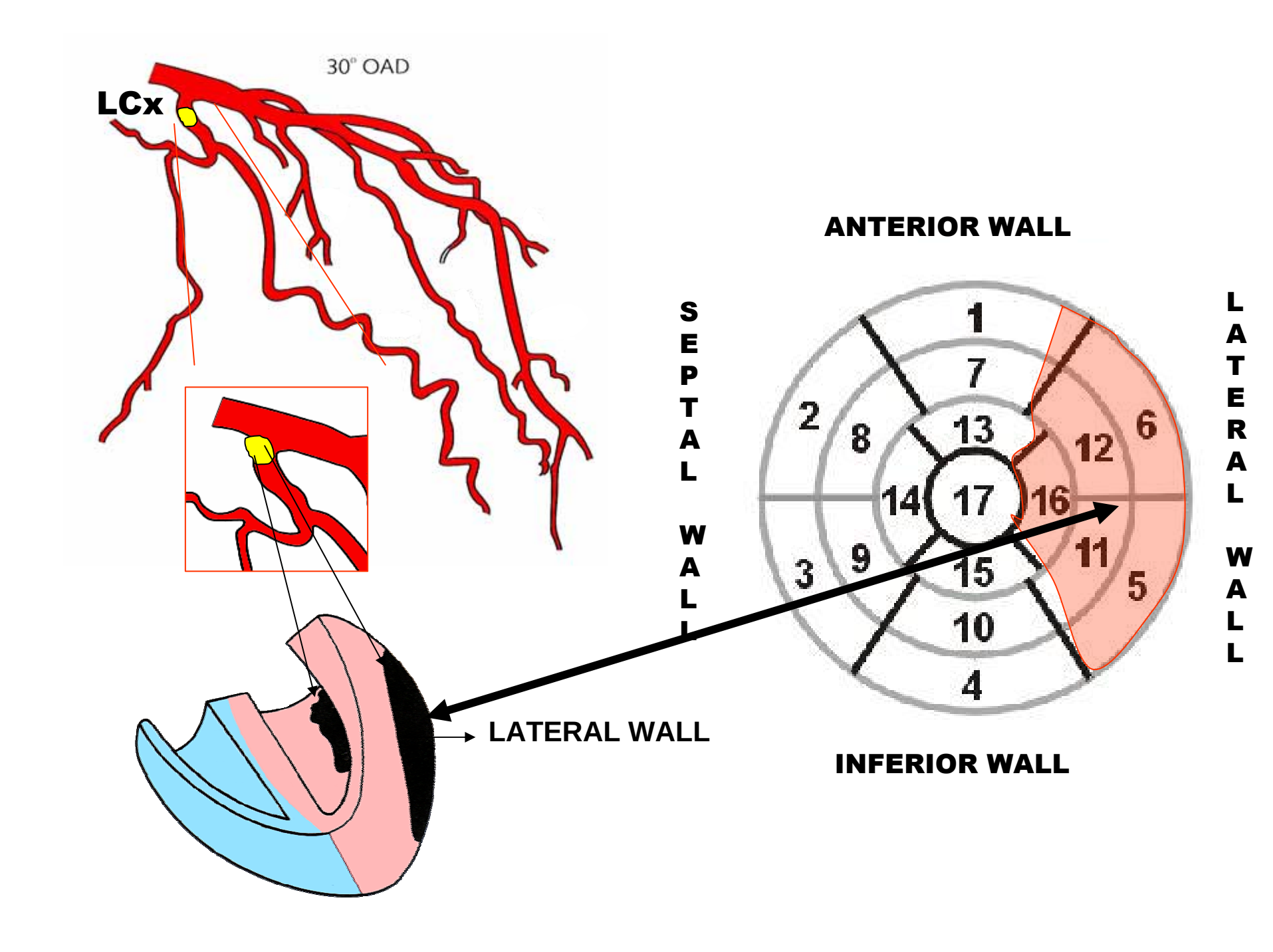




Right QRS axis deviation Near +120º

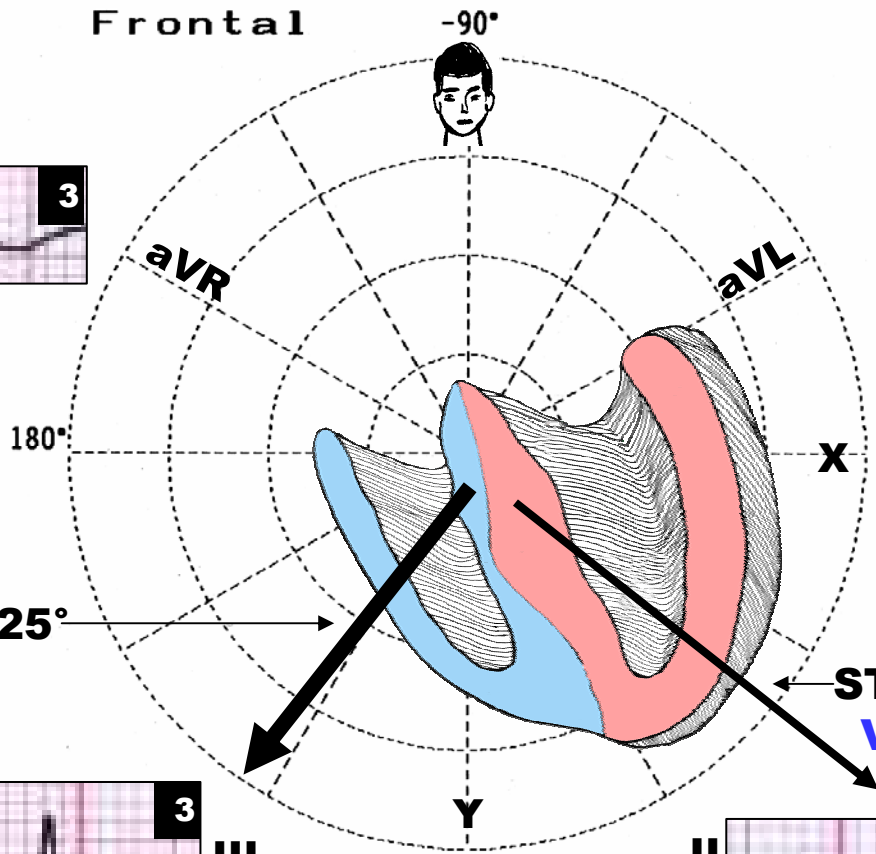
THE ST INJURY VECTOR POINTS TO II AND FLEES Avr

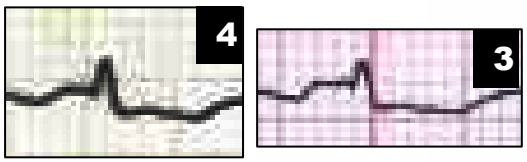
O VETOR DE LESÃO APONTA PARA II E FOGE DE aVR

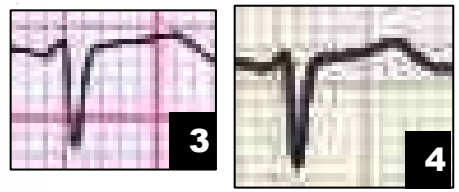

30° OAD
LCx
ANTERIOR WALL
SEPTAL WALL
LATERAL WALL
1
7
2
8
13
6
12
14
17
16
3
9
11
15
5
10
4
LATERAL WALL
INFERIOR WALL

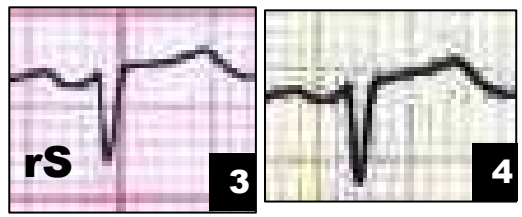
ECGs 3 AND 4 HAVE SIMILAR PATTERNS/

ECG 3 E 4 POSSUEM PADRÕES SEMELHANTES





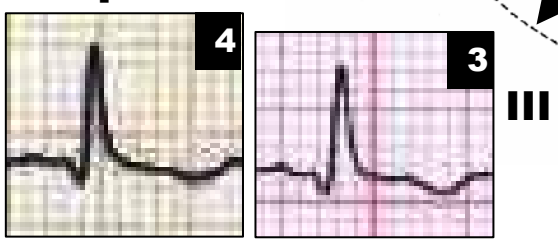


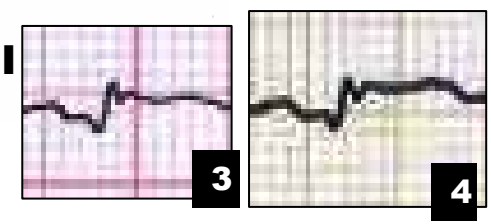


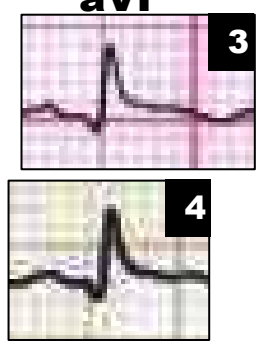
QRS axis +125°

ST INJURY VECTOR

VETOR DE LESÃO



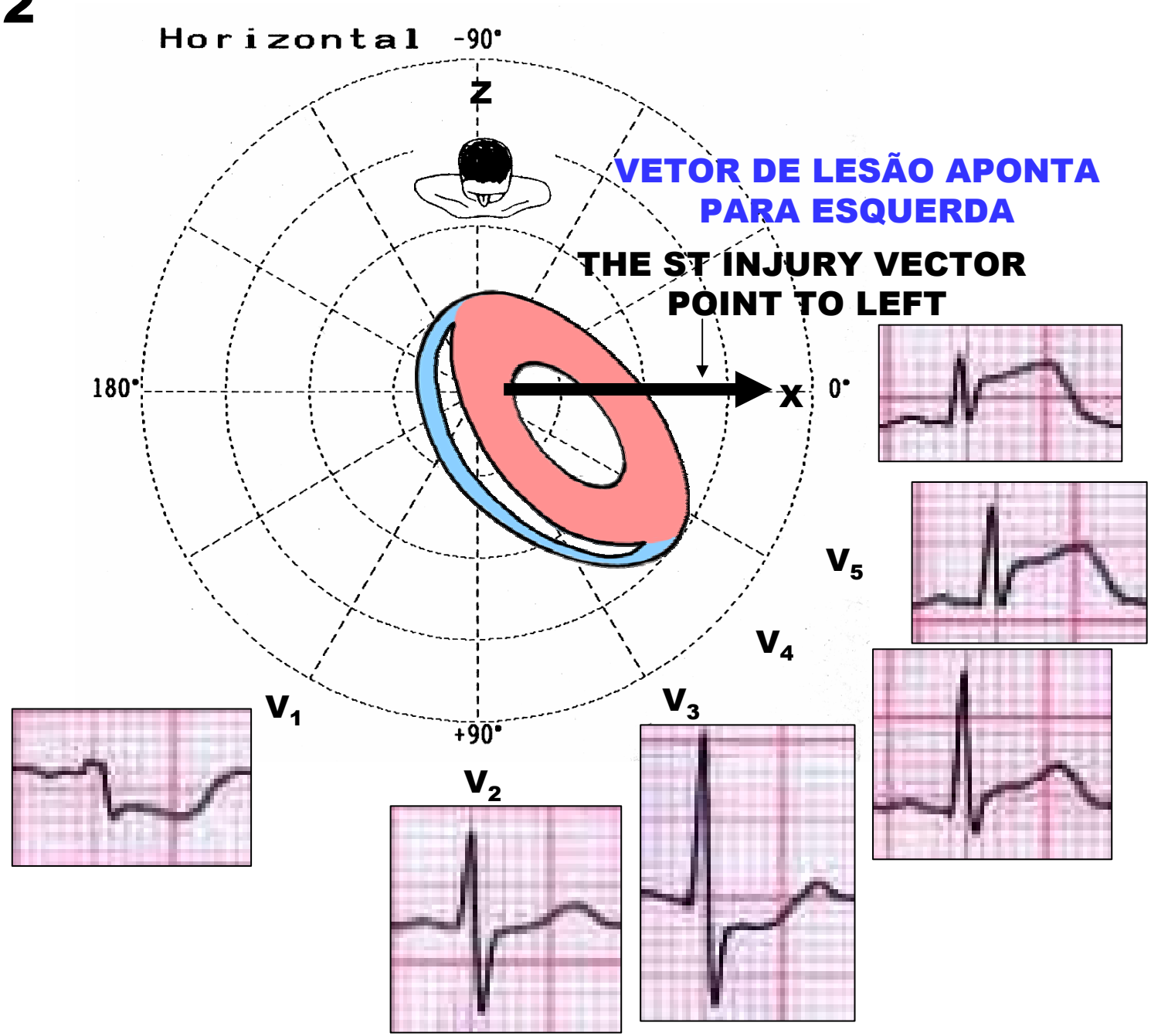




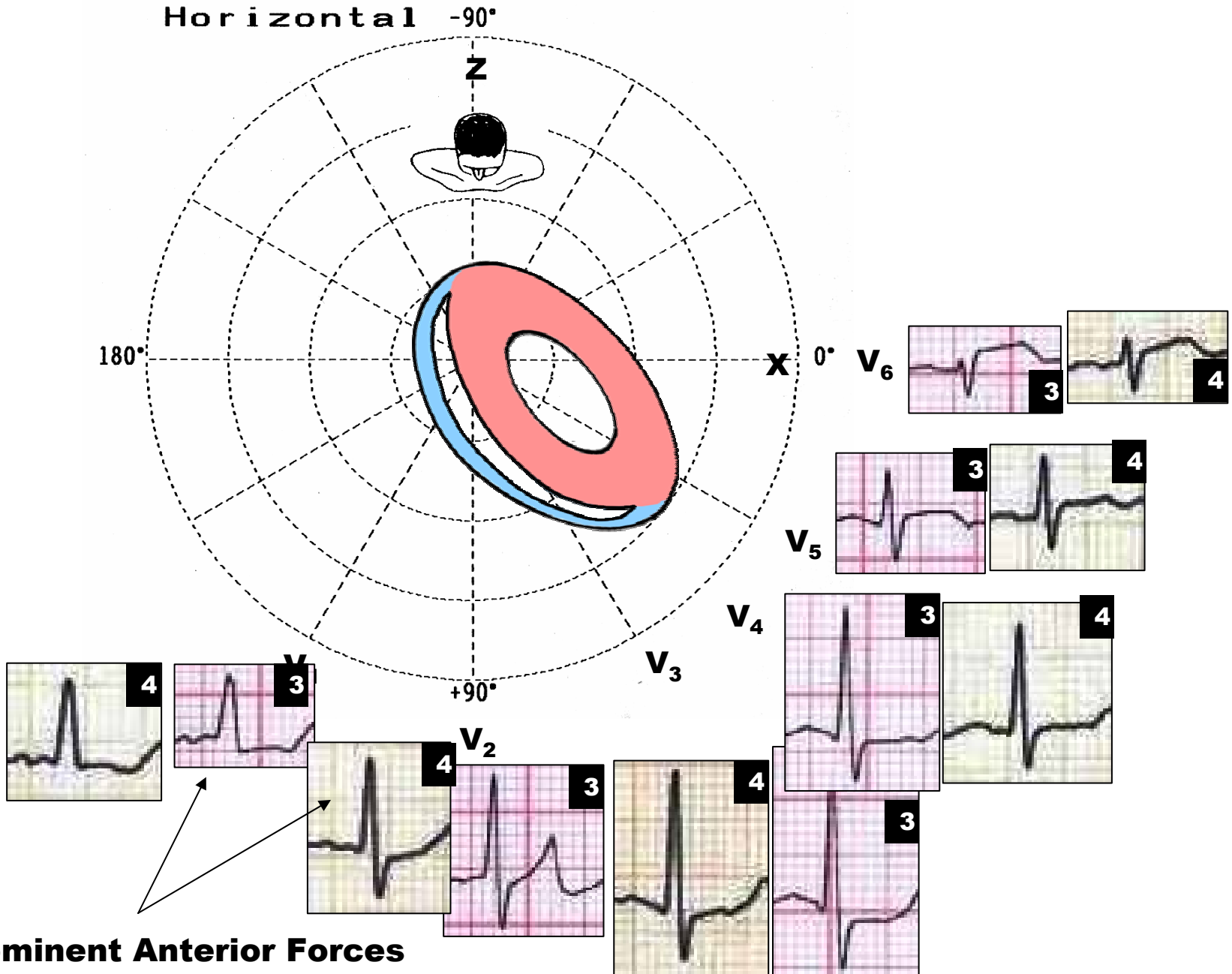
RIGHT AXIS DEVIATION CONSEQUENCE OF LATERAL MI: PSEUDO LPFB

RIGHT AXIS DEVIATION CONSEQUENCE OF LATERAL MI: PSEUDO BLOQUEIO DIVISIONAL PÓSTERO-INFERIOR

ECG 2


Horizontal -90°
Z
180°
0°
X
+90°
VETOR DE LESÃO APONTA PARA ESQUERDA
THE ST INJURY VECTOR POINT TO LEFT
V1
V2
V3
V4
V5

ECGs 3 AND 4 SIMILAR PATTERNS ON HP



PAF: Prominent Anterior Forces

Verouden et al[1]. **investigate the diagnostic accuracy of the conventional ECG algorithm STE in lead III exceeding that in lead II combined with ST-segment depression in lead I or aVL for identification of the infarct-related artery (IRA) in a large cohort of patients undergoing primary percutaneous coronary intervention (PCI) for inferior wall STEMI.**

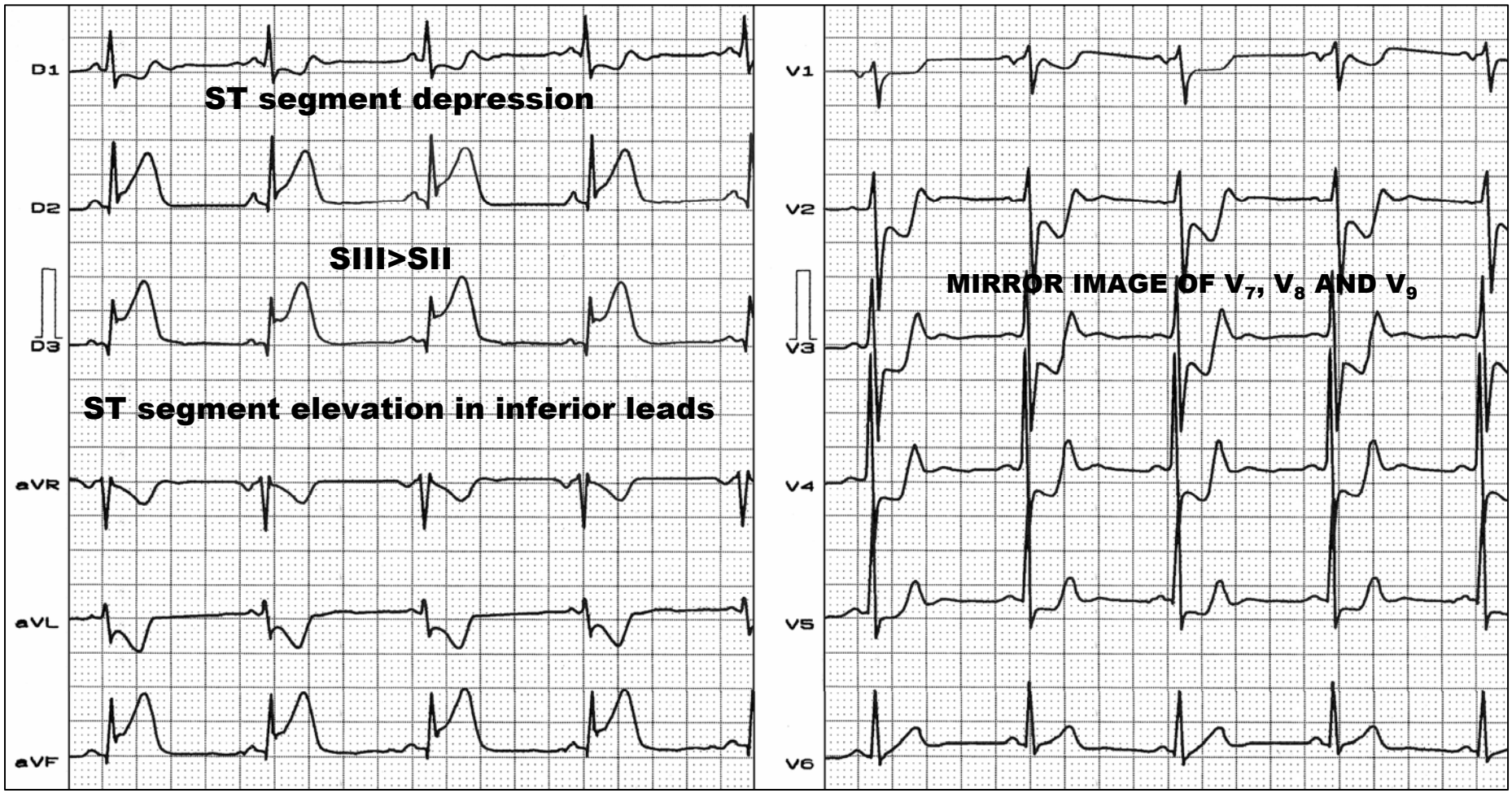
The authors included 1131 patients with inferior STEMI, who underwent primary PCI of whom a pre-procedural 12-lead ECG was available, recorded immediately prior to PCI. The IRA was determined during emergency angiography. Coronary angiography confirmed the RCA as the IRA in 895 patients (79%) with inferior wall STEMI.

Application of the ECG algorithm resulted in 624 true positive cases of acute RCA obstruction (sensitivity: 70%, 95% CI: 67 -73%) and 170 cases with true negative result (specificity: 72%, 95% CI: 66-77%). Sensitivity of >90% was established in patients with cumulative ST-segment deviation above median (>18.5 mm).

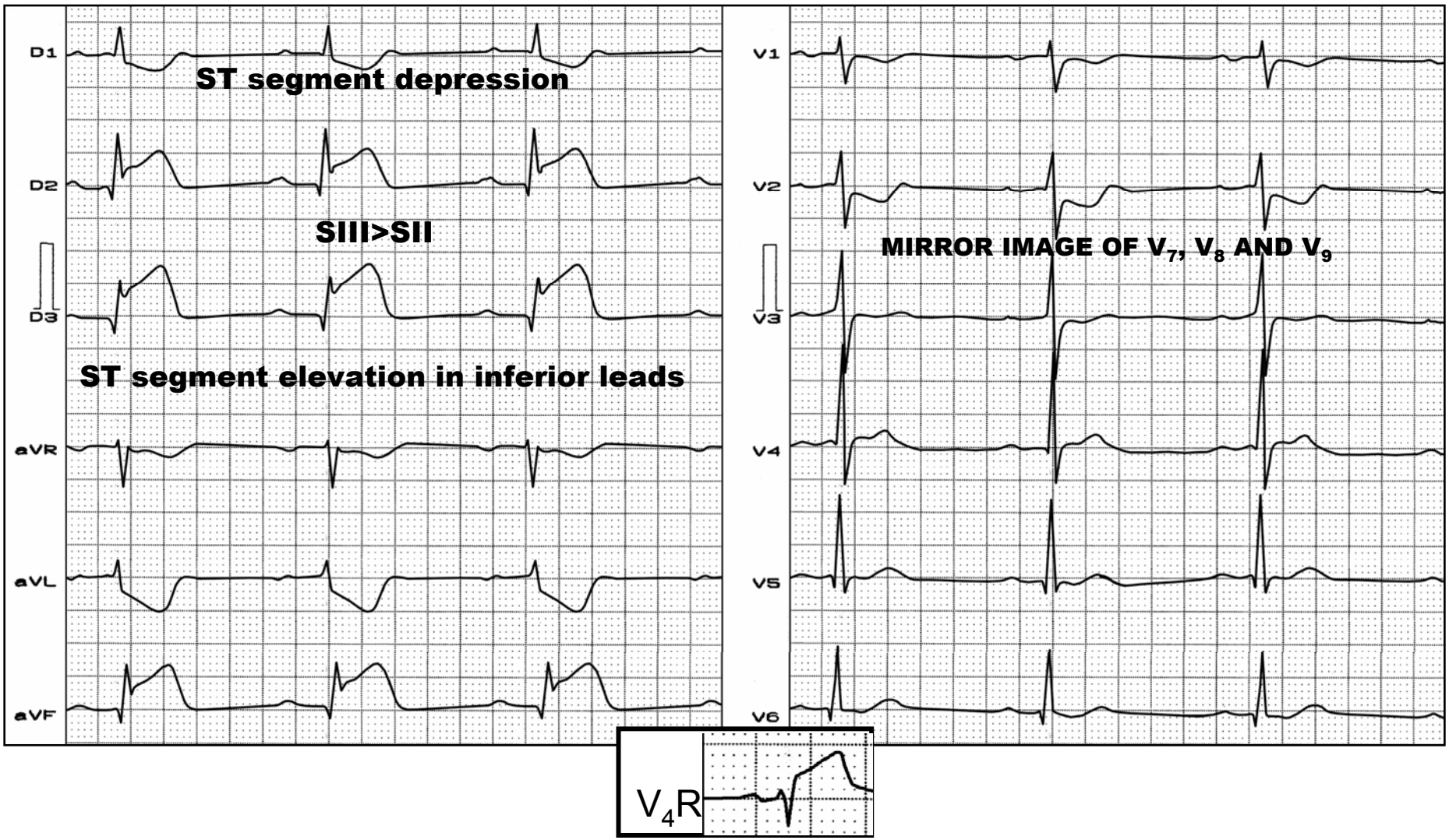
The authors concluded that the conventional ECG algorithm showed a low sensitivity for the non-invasive diagnosis of RCA occlusion in an all-comer, inferior STEMI cohort undergoing primary PCI. Sensitivity was only sufficient in patients with extensive ST-segment deviation.

1. **Verouden NJ, Barwari K, Koch KT, et al Distinguishing the right coronary artery from the left circumflex coronary artery as the infarct-related artery in patients undergoing primary percutaneous coronary intervention for acute inferior myocardial infarction. Europace. 2009 Nov;11(11):1517-21.**

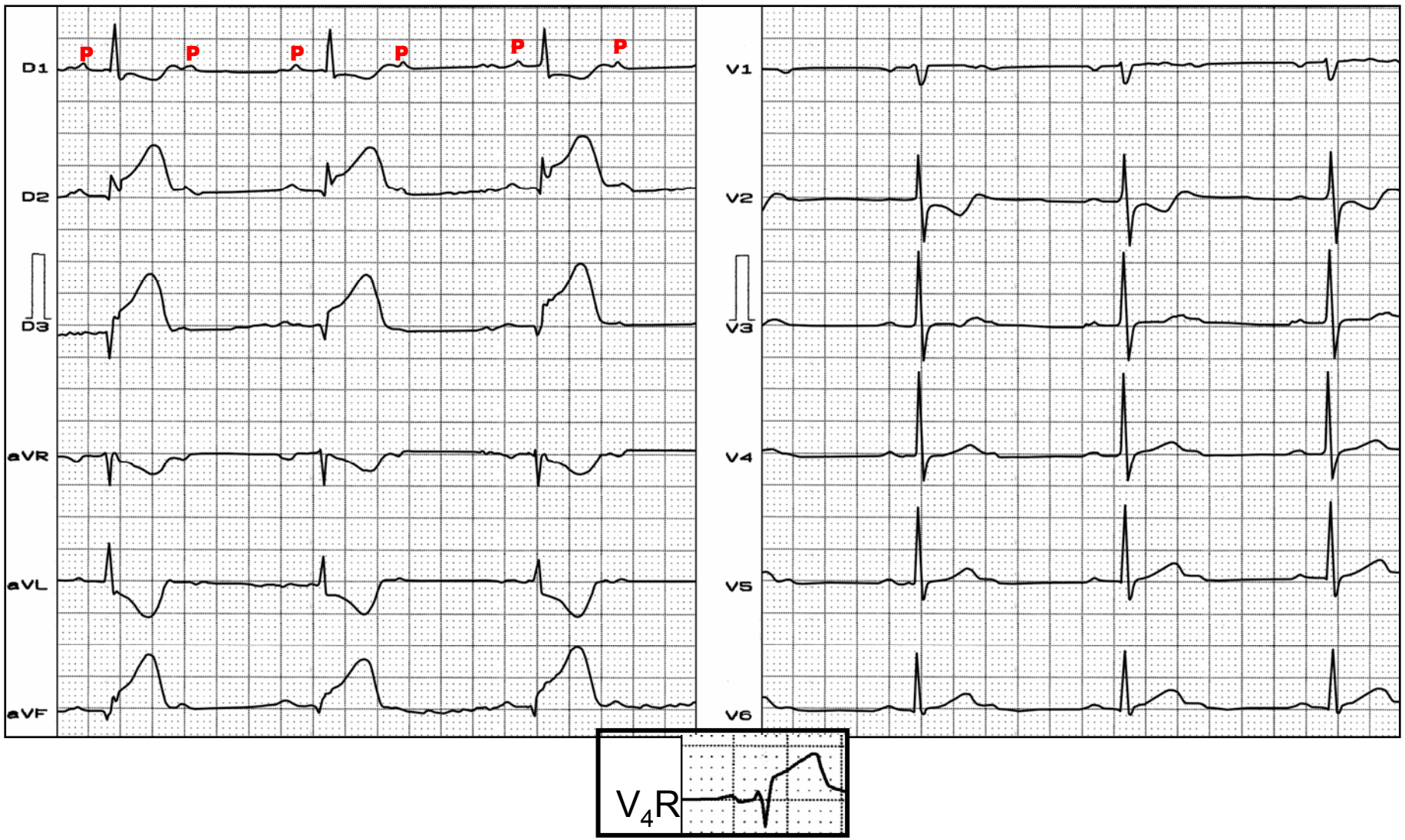
Proximal RCA occlusion



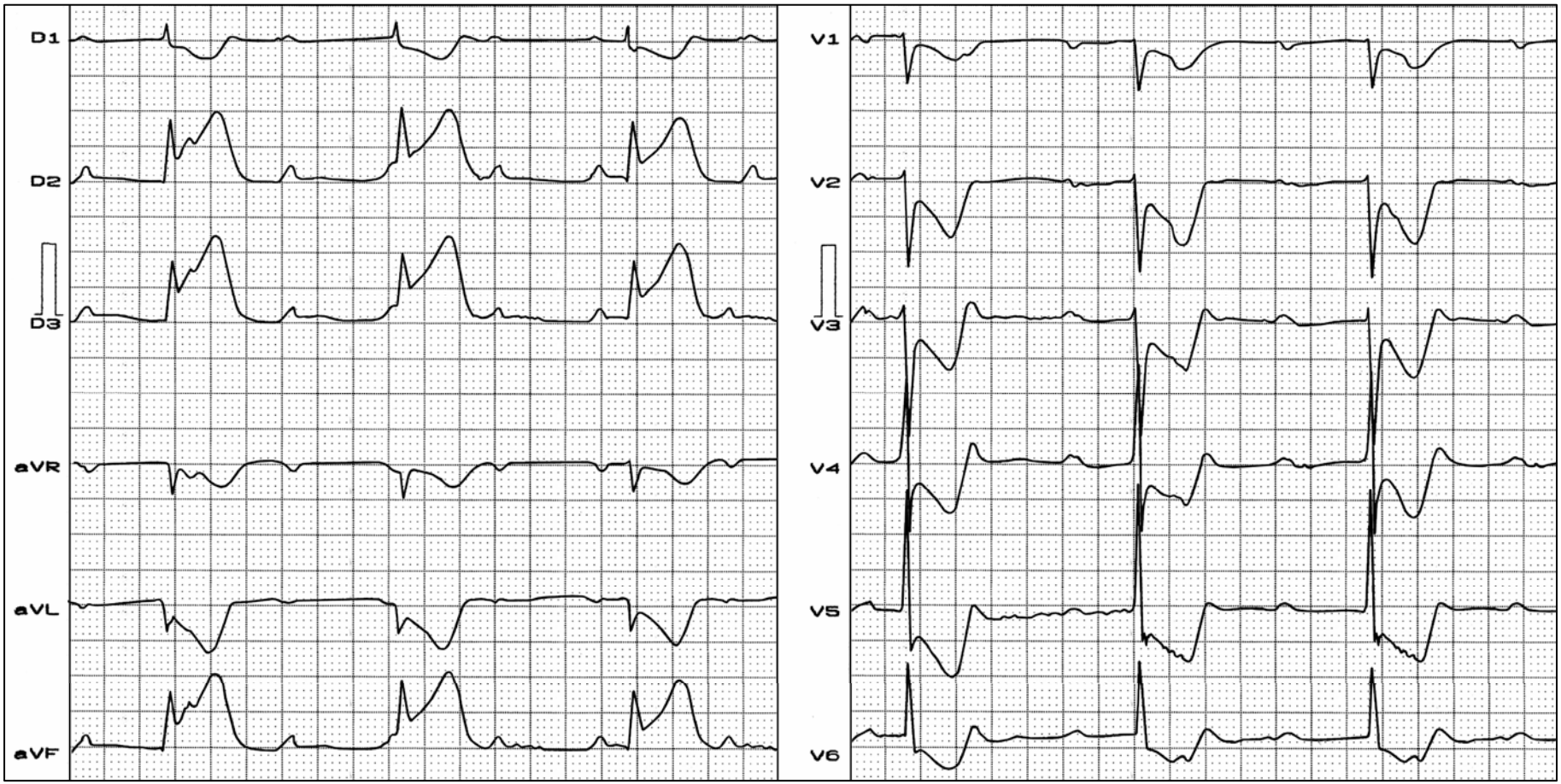
AMI consequence of proximal RCA occlusion complicated with sinus bradicardia, first-degree AV block and RV envolvement: ST segment elevation followed by positive T wave in V_4R



AMI consequence of proximal occlusion RCA complicated with 2:1 AV block and right ventricular envolvement: ST segment elevation in V4R followed by positive T wave

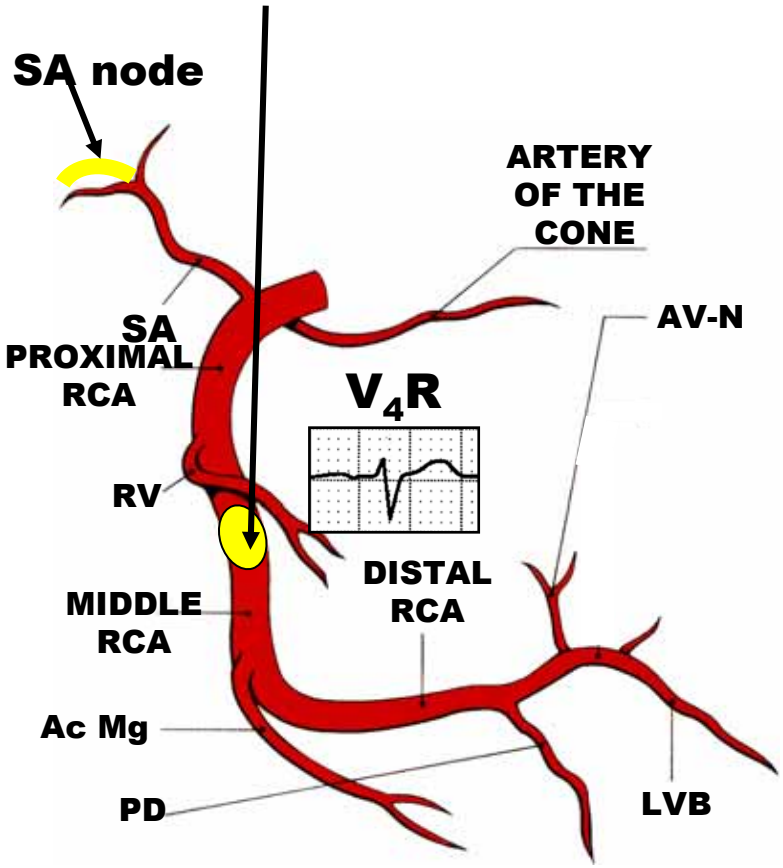


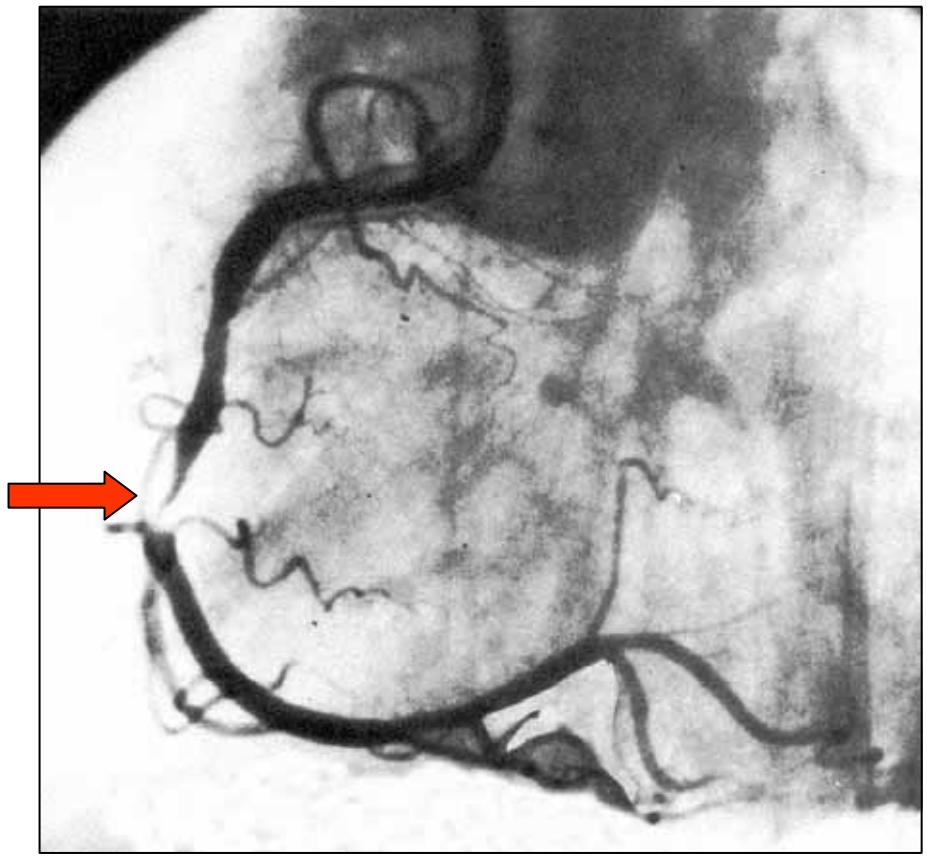
Third degree AV block consequence of AMI by obstruction of RCA. QRS complexes are narrow indicating suprahisian block.



MIDDLE PORTION OCCLUSION
RIGHT CORONARY ARTERY (RCA)

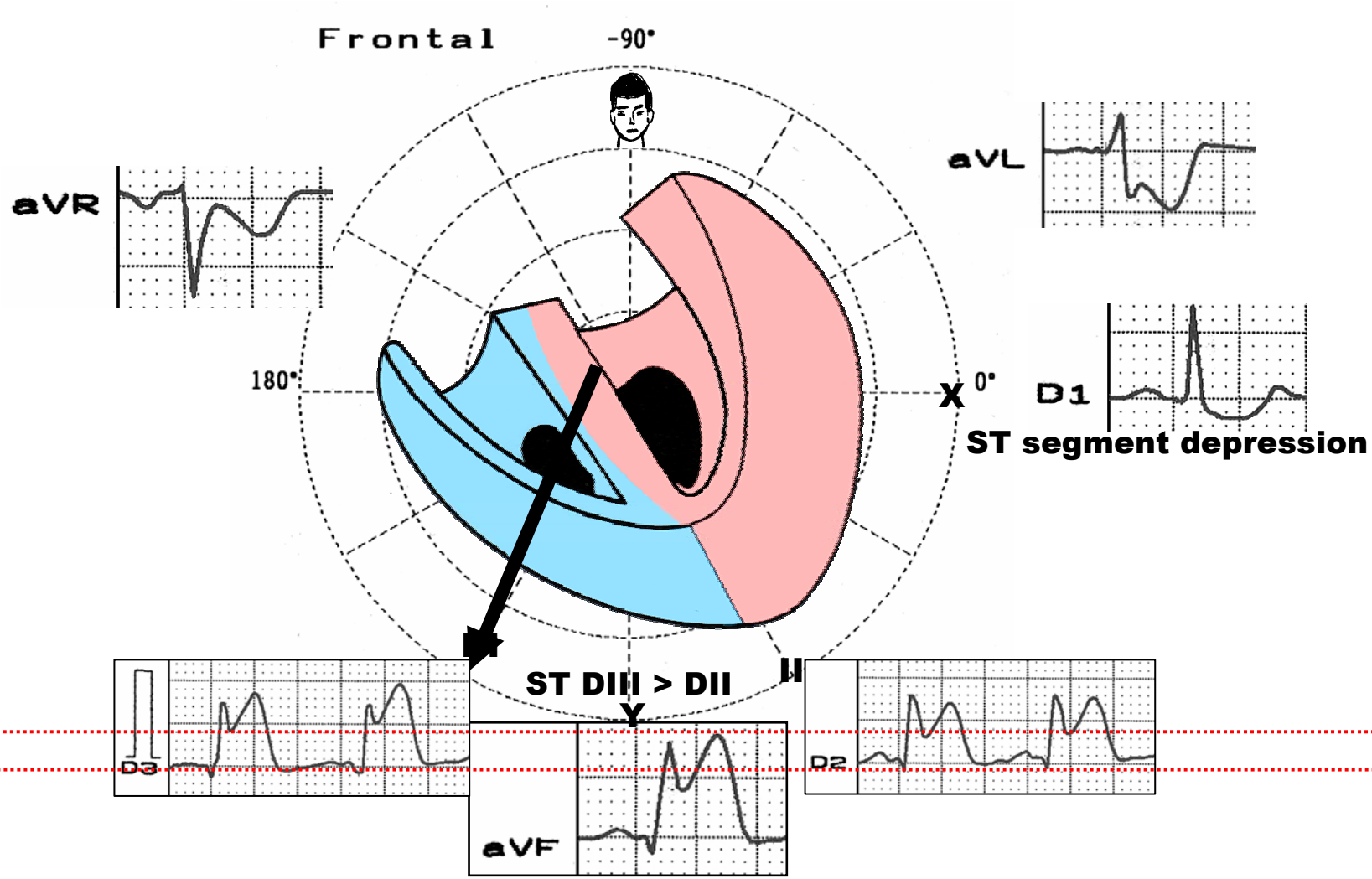
OCCLUSION LOCATION

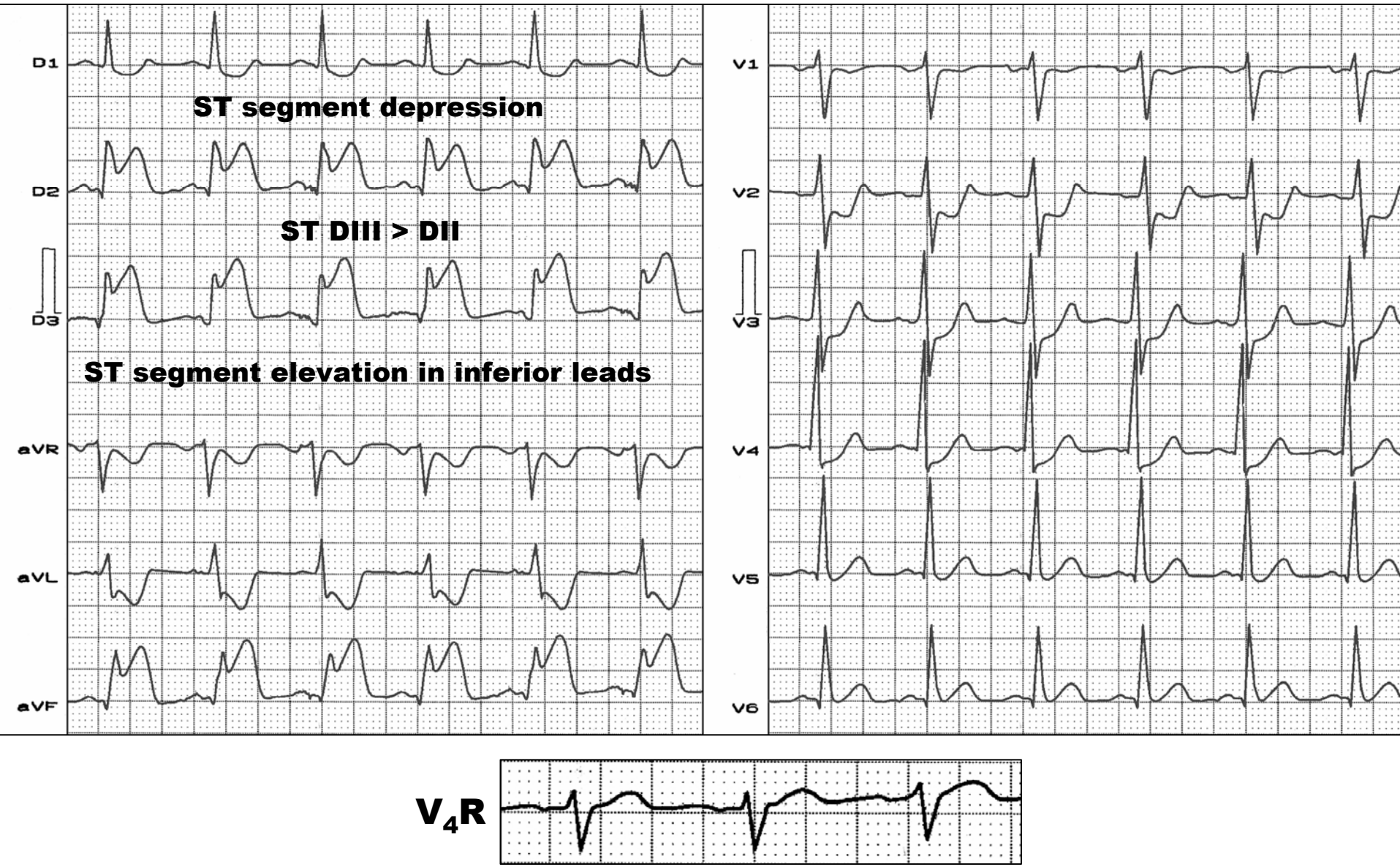




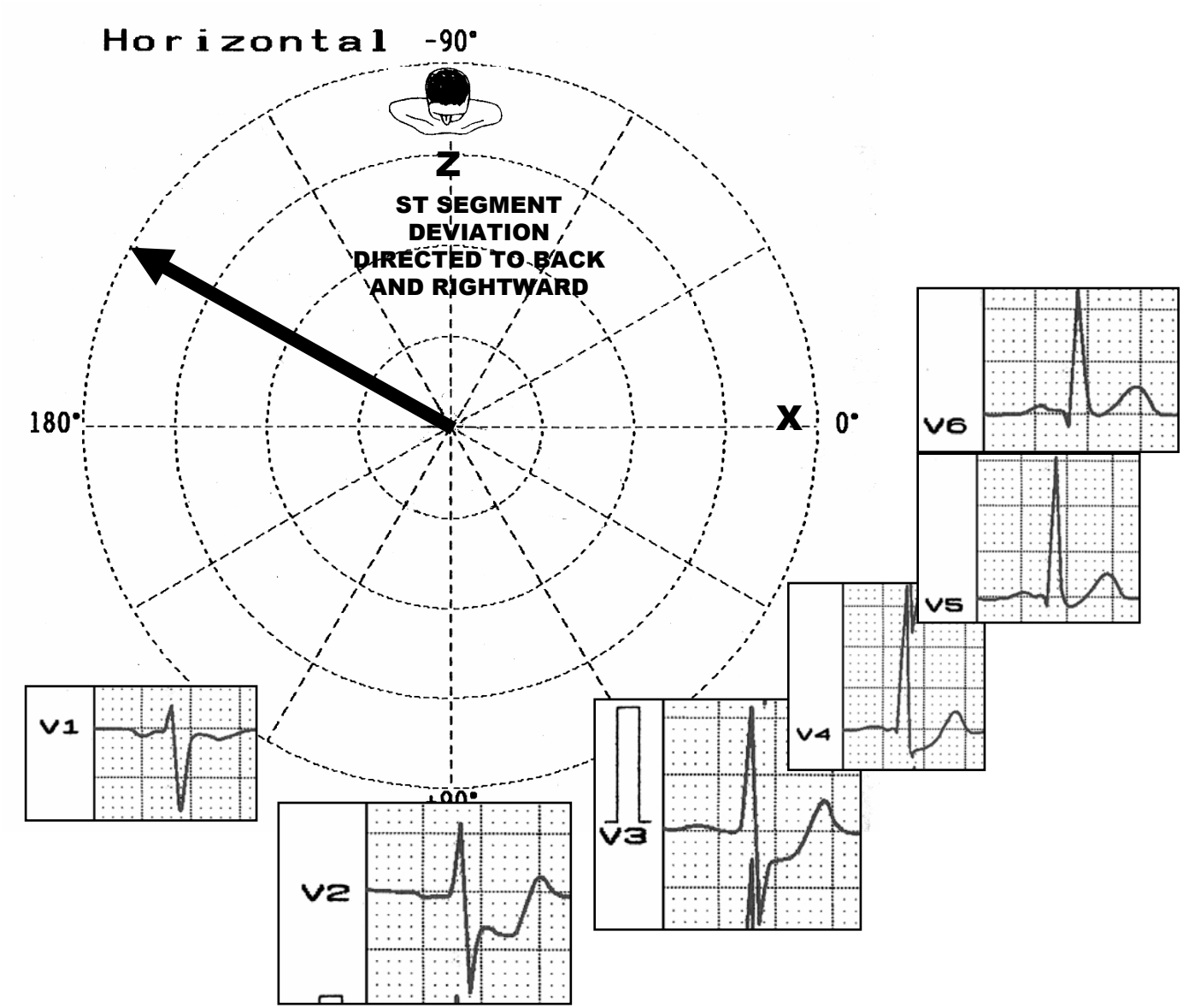
Cineangiography of the previous patient. The red arrow points out the total obstruction in the middle portion of the RCA. The accessory V_4R lead has a isoelectric ST segment, because the RCA obstruction is located distal related to RV artery (without RV Infarction).

ST segment elevation in inferior leads. III>II because the ST deviation vector pointed to III



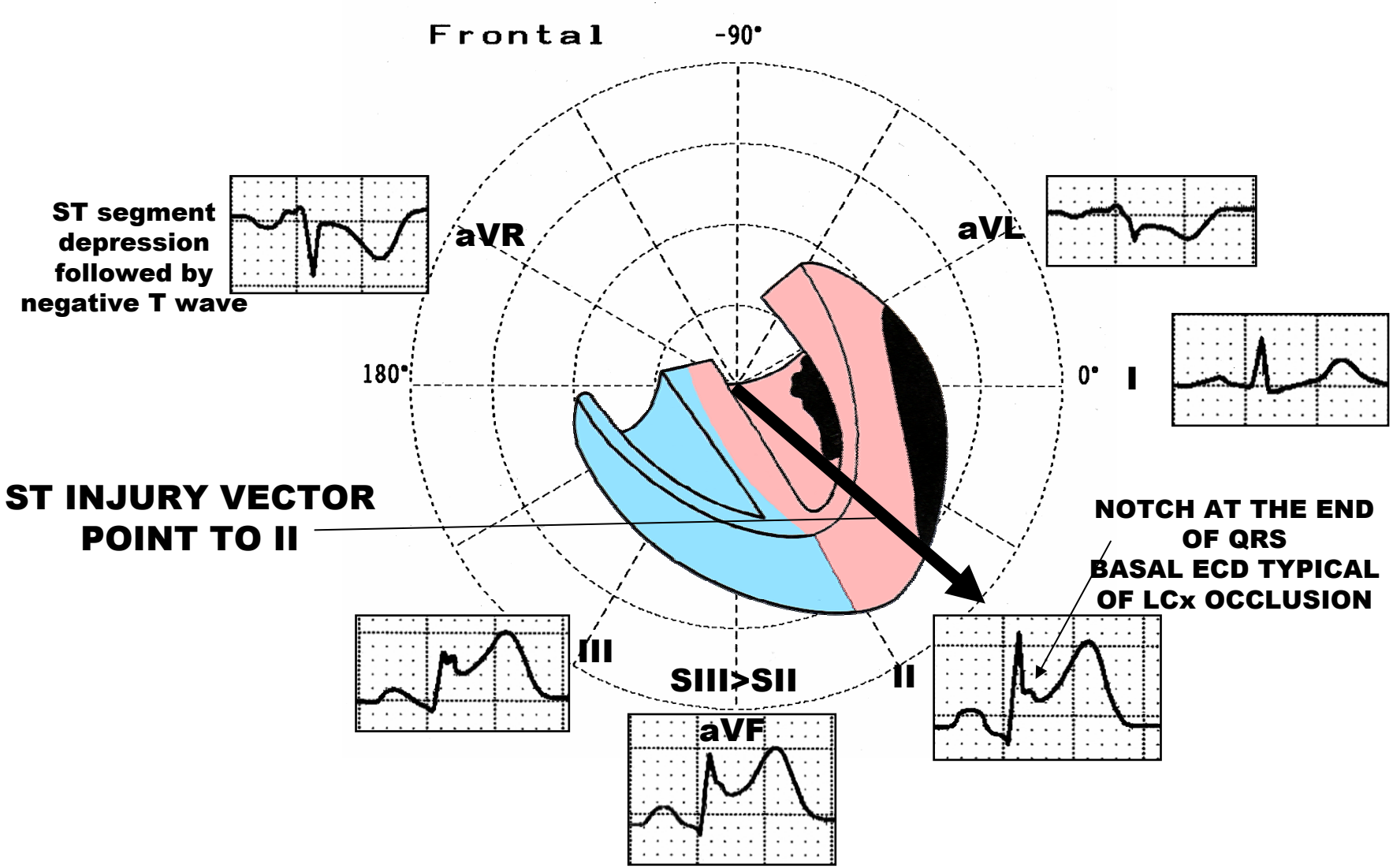

D1
D2
D3
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
ST segment depression
ST DIII > DII
ST segment elevation in inferior leads

V_4R

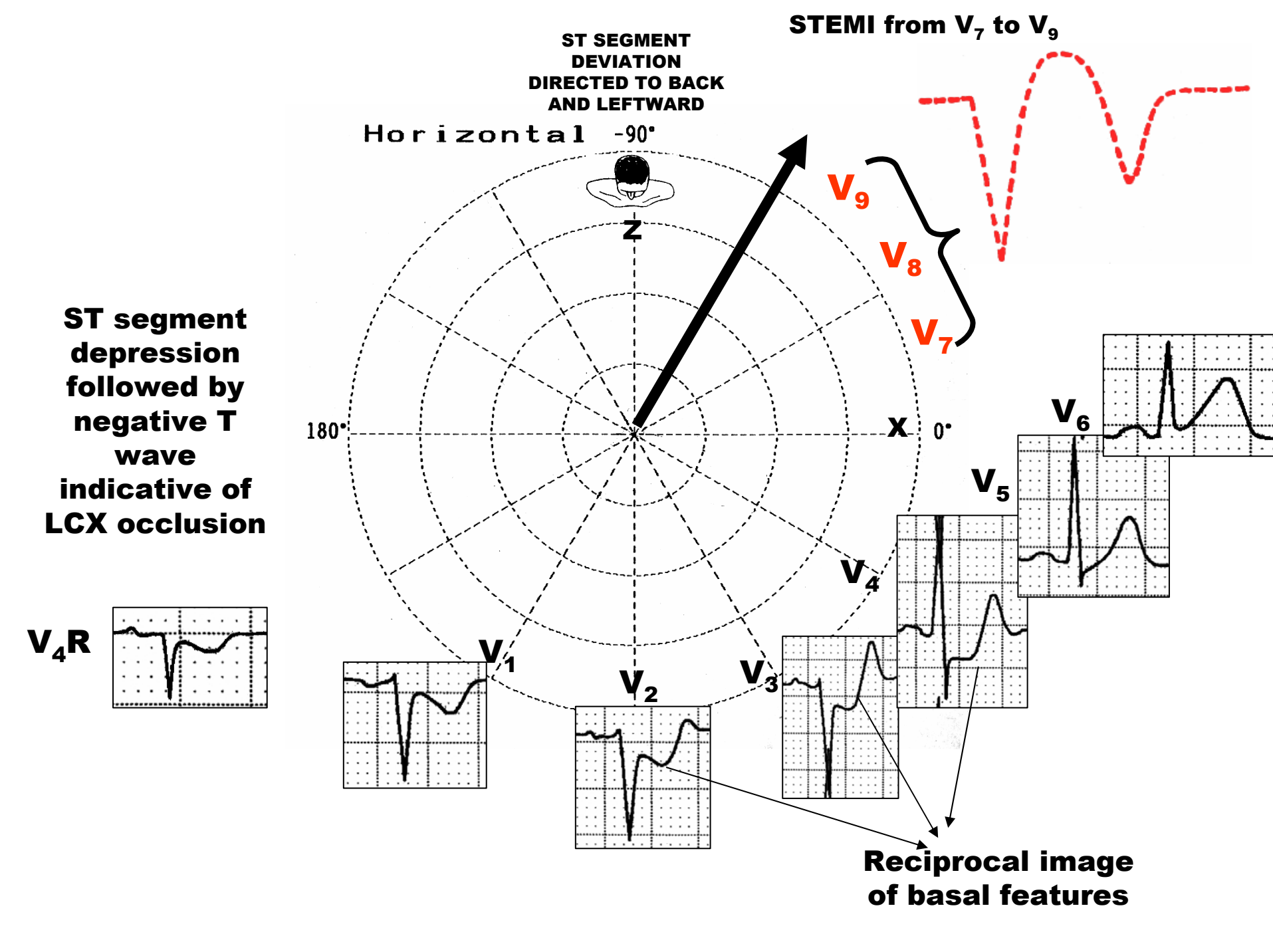

Horizontal
-90°
Z
ST SEGMENT
DEVIATION
DIRECTED TO BACK
AND RIGHTWARD
180°
X
0°
+90°
V6
V5
V4
V3
V2
V1
V4R

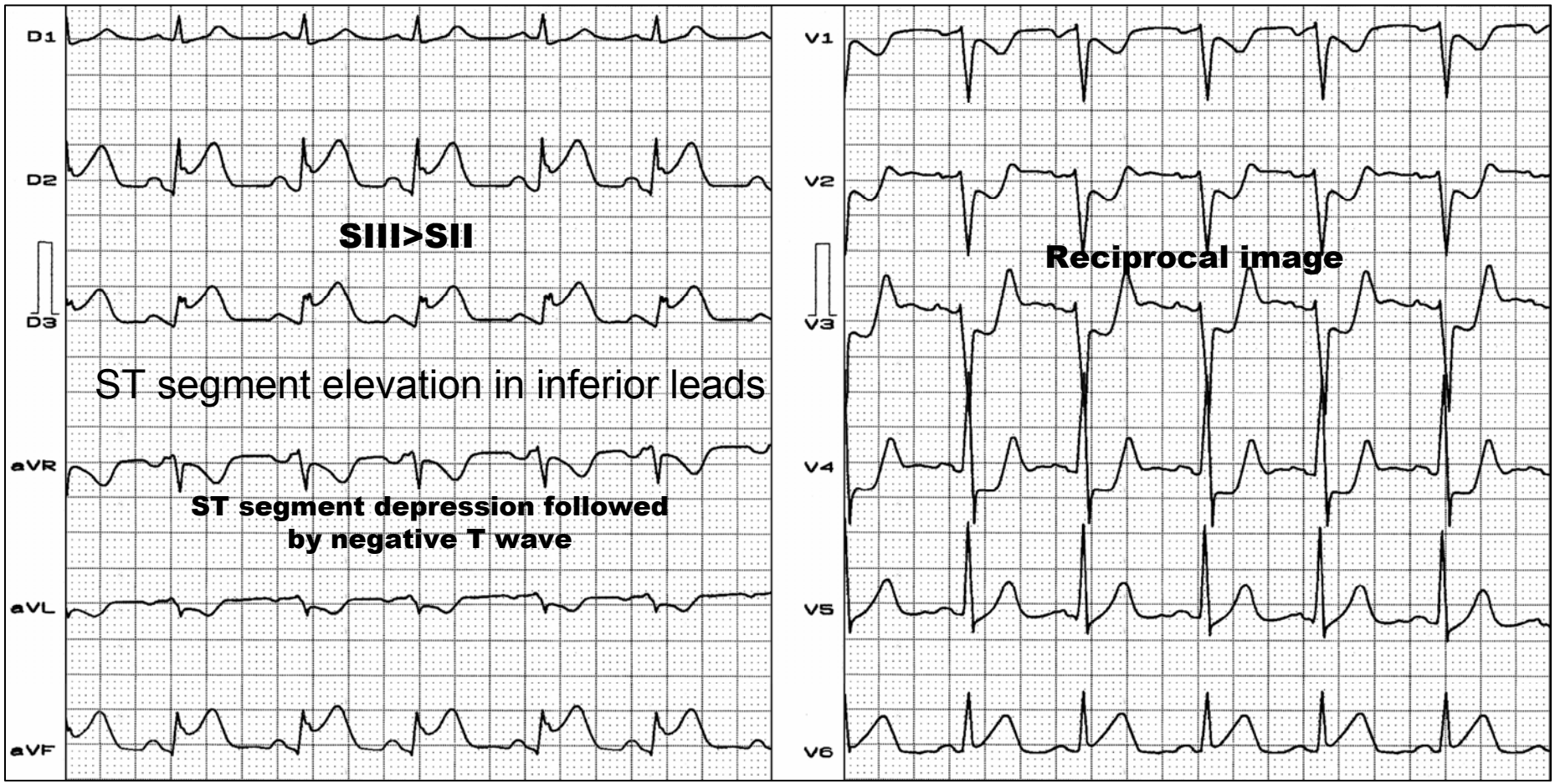
OCCLUSION OF
LEFT CIRCUNFLEX ARTERY (LCX)

Strong agreement between the direction of the ST injury vector and the location of myocardial ischemia. The ST injury vector may be the key to higher diagnostic accuracy for inferobasal transmural ischemia and may help distinguishing between RCA and LCX occlusions in the acute phase[1].



1. Andersen MP, Terkelsen CJ, Sørensen JT, et al. The ST injury vector: electrocardiogram-based estimation of location and extent of myocardial ischemia.J Electrocardiol. 2010 Mar-Apr;43:121-31.


ST SEGMENT DEVIATION DIRECTED TO BACK AND LEFTWARD
STEMI from V7 to V9
Horizontal -90°
Z
180°
X
0°
V9
V8
V7
V6
V5
V4
V3
V2
V1
V4R
ST segment depression followed by negative T wave indicative of LCX occlusion
Reciprocal image of basal features



V_4R

ST segment depression in V_4R followed by negative T wave

Lead V_4R faces the RV free wall; it also reflects ischemia in the basallateral wall lying opposite and manifests as ST-segment depression. Jim et al[1] evaluate the usefulness of V_4R ST-segment depression in distinguishing proximal from distal LCX occlusion in acute inferobasal wall MI (In old nomenclature inferodorsal IM). The authors retrospectively analyzed 239 patients who had first acute inferobasal MI, were admitted within 6 h from onset of symptom, and had coronary angiography performed within 4 weeks.

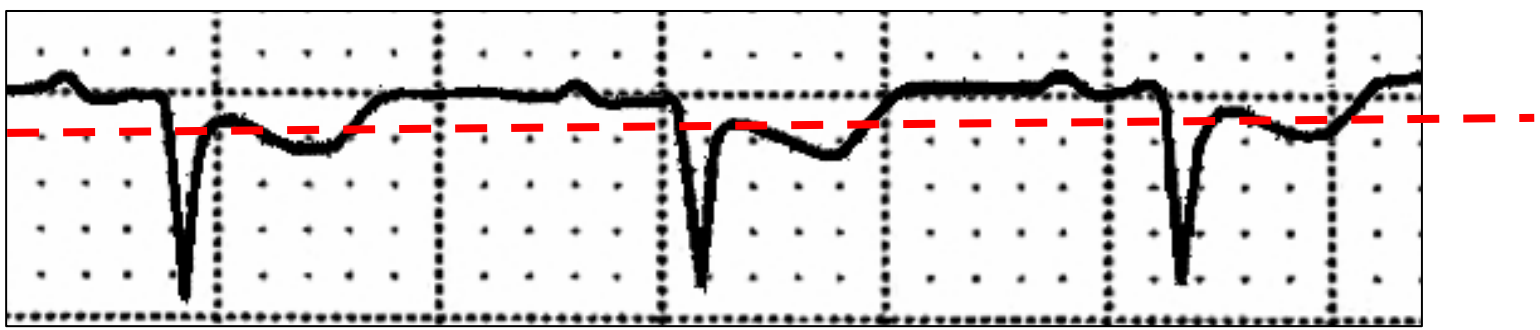
Patients who had bundle-branch block or concomitant significant stenoses in the proximal and distal segments of the same vessel or of both vessels were excluded.

The ECGs and angiographic findings were reviewed by two independent groups of investigators.

V_4R ST-segment depression ≥ 1.0 mm was found in 8 of 46 patients (17.4%) with LCX occlusion but none (0%) with RCA occlusion. Among the group with LCX occlusion, the mean magnitude of V_4R ST-segment depression was greater in proximal than distal occlusion.

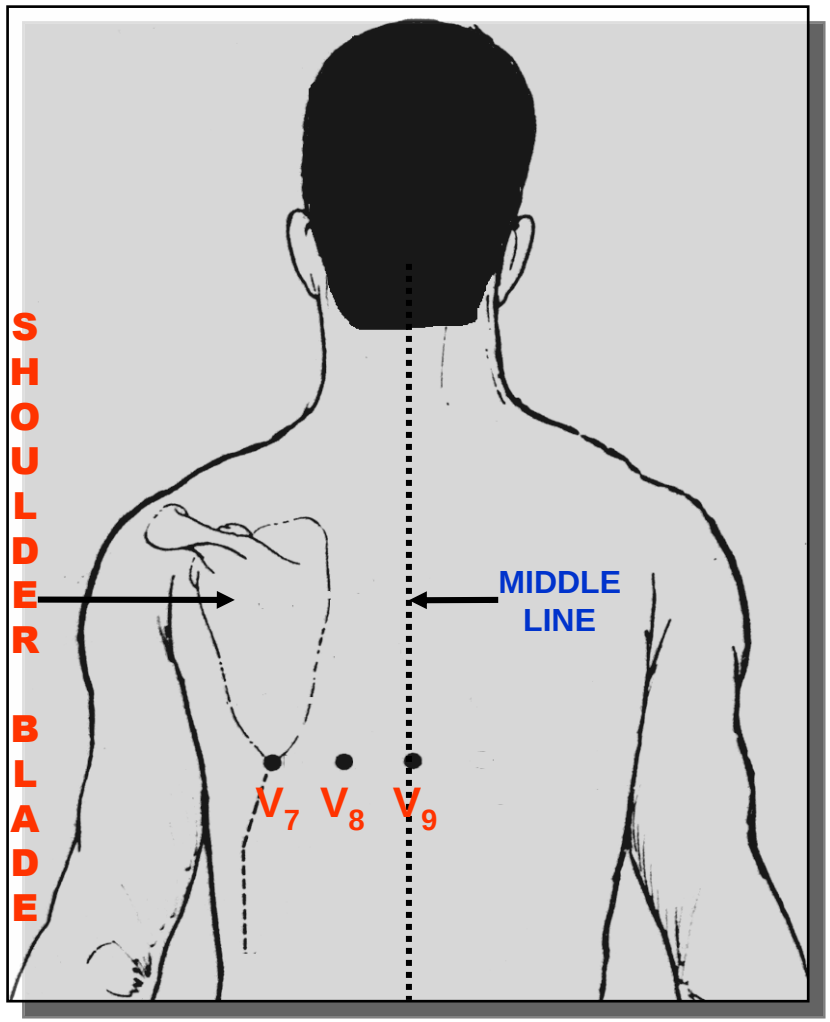
V_4R ST-segment depression ≥1.0 mm was found in 8 of 14 patients (57.1%) with proximal occlusion but none (0%) in 32 patients with distal occlusion. The sensitivity and specificity to predict proximal occlusion were 57.1 and 100%, respectively.

The authors concluded that V_4R ST-segment depression ≥ 1.0mm was not useful for differentiating LCX and RCA occlusion because of its low sensitivity. It is a fairly sensitive and **very specific sign of proximal LCX occlusion**.



1. **Jim MH, Ho HH, Siu CW, et al Value of ST-segment depression in lead V4R in predicting proximal against distal left circumflex artery occlusion in acute inferoposterior myocardial infarction. Clin Cardiol. 2007 Jan;30:36-41.**

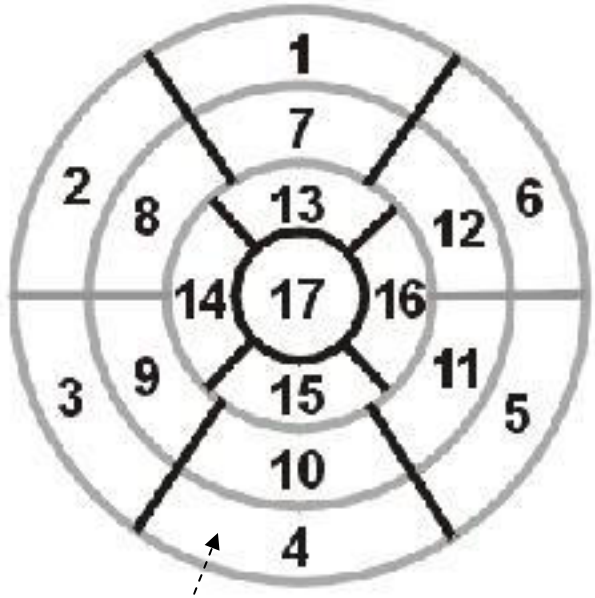
ACCESSORY DORSAL LEADS



The accessory three posterior chest leads are located between the left shoulder blade and the spine V_7, V_8 and V_9 leads.(ECG with 15 leads)

A significant proportion of patients with MI are missed upon initial presentation to the emergency department (ED). The 12-lead ECG has a low sensitivity for the detection of AMI, especially if the culprit lesion is in the LCX.

Raed aqel et al[1] evaluate the benefit of adding 3 posterior chest leads in addition to the standard 12 leads to detect ischemia resulting from LCX, using a model of temporary balloon occlusion to produce ischemia. They studied 53 consecutive patients who underwent clinically indicated coronary interventions. At the time of coronary angiography, the balloon was inflated to produce complete occlusion of the proximal LCX. They recorded and analyzed the changes noted on the 15-lead.



ECG, which included 3 posterior leads in addition to the standard 12 leads(ECG with 15 leads).

In response to acute occlusion of the LCX, the posterior chest leads showed more ST elevation than the other leads, and more patients had ST elevation in the posterior leads than in any other lead. The 15-lead ECG was able to detect≥0.5 mm and ≥ 1 mm ST elevation in any 2 contiguous leads more frequently than the 12-lead ECG.

The 15-lead ECG identified more patients with **inferobasal[2] (segment 4)** (posterior in old nomenclature[2]) myocardial wall ischemia because of temporary balloon occlusion of the LCX than the 12-lead ECG. This information may enhance the detection of inferobasal MI in the ED and potentially facilitate early institution of reperfusion therapy. What is important is the truth[3].

1. **Aqel RA, Hage FG, Ellipeddi P, et al. Usefulness of three posterior chest leads for the detection of posterior wall acute myocardial infarction.Am J Cardiol. 2009 Jan 15;103:159-164.**
2. **Bayes de Luna A. New heart wall terminology and new electrocardiographic classification of Q-wave myocardial infarction based on correlations with magnetic resonance imaging]. Rev Esp Cardiol. 2007 Jul;60(7):683-9.**
3. **Bayés de Luna A, Goldwasser D. What is important is the truth. J Electrocardiol. 2011 Jan-Feb;44:58-59.**

Acute occlusion of the LCX can be difficult to diagnose. From et al[1] the present study was to assess the incidence of LCX occlusion in patients with AMI requiring PCI. The frequency of STEMI versus Non-STEMI presentation among them, and to correlate the ECG findings with the outcomes. The clinical characteristics and outcomes of 1,500 consecutive patients with AMI within 7 days before PCI of a single acutely occluded culprit vessel were included.
Of the 1,500 patients, the culprit lesion was located in the RCA, LAD, or LCX artery in 44.7%, 35.8%, and 19.5% of patients, respectively.

Of the 1,500 patients, 72% presented with STEMI, but only 43% were patients with a LCX lesion (n = 127). PCI was significantly less likely (80%, 83%, and 70% for RCA, LAD, and LCX to be performed within 24 hours for LCX occlusions than for occlusions in the other territories. Among those with a Non-STSEMI, the highest post-PCI troponin levels were in patients with a LCX occlusion. No significant difference was found in the in-hospital mortality or major adverse cardiovascular event rates for RCA, LAD, and LCX occlusions, respectively.

In clinical practice, the LCX artery is the least frequent culprit vessel among patients treated invasively for AMI. Patients with LCX occlusion are less likely to present with STEMI and have emergency PCI. The study results suggest that detection of these patients has been suboptimal, highlighting the need to improve the diagnostic approach toward the detection of an acutely occluded LCX.

1. **From AM, Best PJ, Lennon RJ, et al. Acute myocardial infarction due to left circumflex artery occlusion and significance of ST-segment elevation. Am J Cardiol. 2010 Oct 15;106:1081-1085.**

The Infarct-Related Zrtery (IRA) could not always be identified by ECG. Zhang et al[1] attempted to explore the reason for failed IRA identification by ECG based on the comparison between ECG records and coronaryography findings.

All 18-lead ECG records were compared with respective angiographic findings in 1024 consecutive patients with STEMI. More than two continous18-lead ECG records were performed within 12 hours of the symptom onset in all patients. Patients with previous MI, coronary artery bypass, pacing or ECG evidence of LBBB and angiography was performed > 12 hours time from symptom onset were excluded.

Of all 1024 patients enrolled, the IRA were correctly identified in 854 cases and identified wrong in 96 cases and could not be identified in 74 cases by ECG. Of the failed identification in these 170 cases, IRA was LCX in 76 (44.7%)cases, RCA in 66 (38.8%) cases, LAD in 20 (11.8%), ramus medianus branch in 7 (4.1%) cases, and LM in 1(0.6%) case. Double-vessel and triple-vessel diseases were recorded in 27(15.9%) patients and 47(27.6%) patients respectively. Early repolarization syndrome occurred in 8 (4.7%) patients, and dextrocardia in 1 patient (0.6%). Angiographic study showed acute occlusion of a small branch in 6 (3.5%) patients.

The authors concluded Coronary collateral vessel can mislead judgments of the IRA by ECG. **When the IRA can not be determined by ECG, LCX is most likely to be the culprit vessel**. Occasionally, early repolarization syndrome and anatomic variation of the coronary artery or heart and a small branch occlusion could be causes of misjudgments of IRA by ECG.

1. **Zhang XJ, Yan HB, Zheng B, et al. Reasons for failed electrocardiographic identification of the infarct-related artery in patients with ST-elevation acute myocardial infarction. Zhonghua Xin Xue Guan Bing Za Zhi. 2010 Oct;38:914-917.**