



EKG - Pearls and Pitfalls: Ischämie und Myokardinfarkt

W. Haverkamp



Kardiologie im Spreebogen
Berlin, Germany

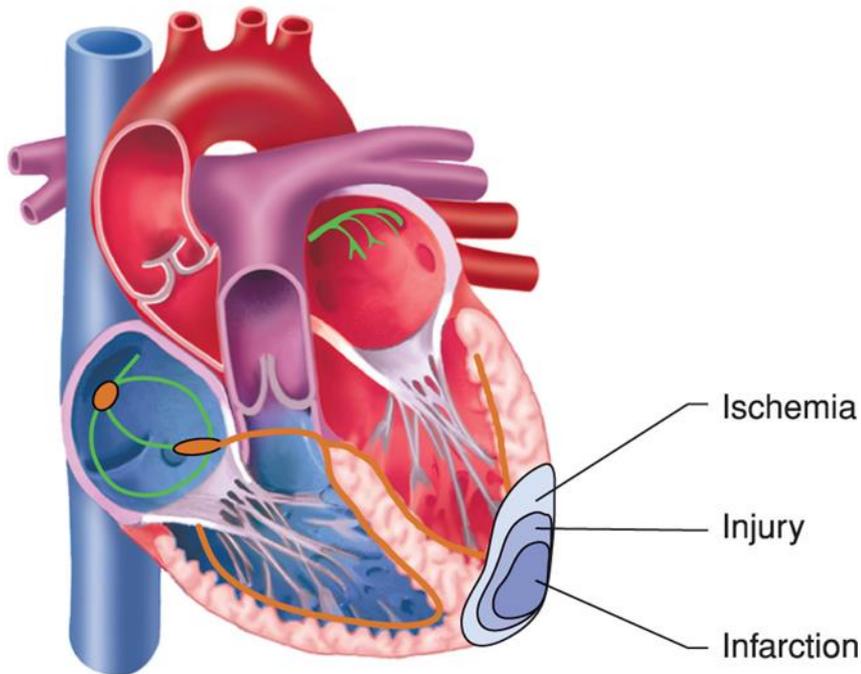


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Berlin, Germany

Akutes Koronarsyndrom: Formen

- **Instabile Angina pectoris:** kein Anstieg von Troponin T oder I, mit/ohne EKG-Veränderungen (keine ST-Hebungen).
- **Nicht-transmuraler Infarkt (NSTEMI = non ST-segment-elevation myocardial infarction):** EKG-Veränderungen (keine ST-Hebungen), Anstieg von Troponinen.
- **Transmuraler Infarkt (STEMI = ST-segment-elevation myocardial infarction):** Nachweis von ST-Hebungen und Anstieg von Troponinen.

Akutes Koronarsyndrom: EKG

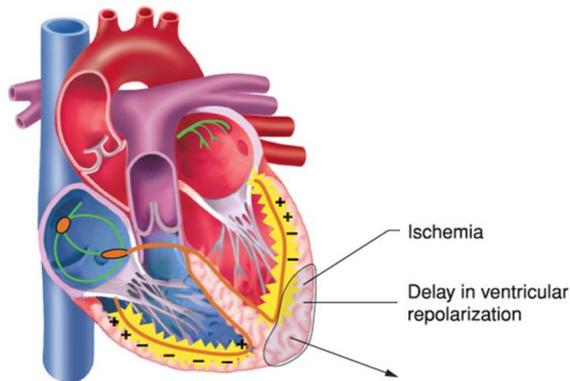


- Keine EKG-Veränderungen
- Ischämie (ischemia)
- Verletzung (injury)
- Nekrose (necrosis)

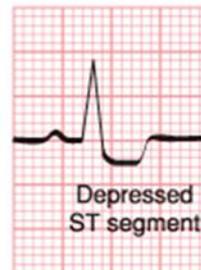
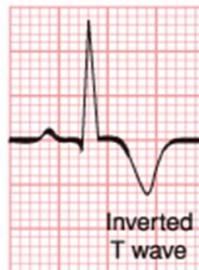
EKG: Ischämie und Myokardinfarkt

- **Ischämie (ischemia)**
- **Verletzung (injury)**
- **Nekrose (necrosis)**

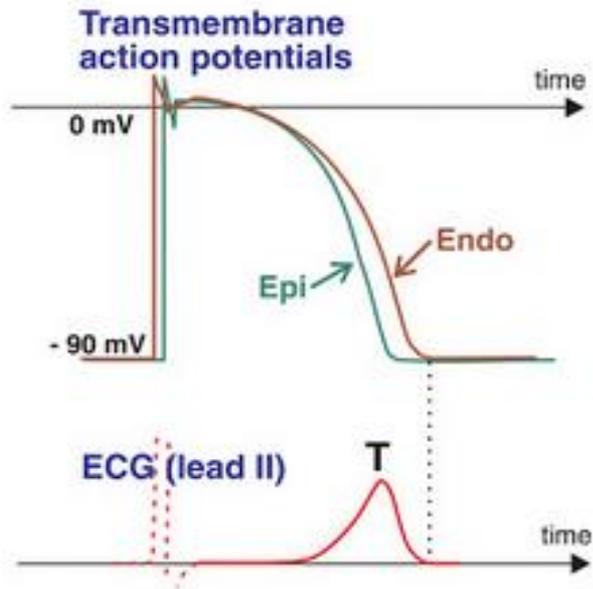
Myokardischämie



- Funktionelle Veränderung des Aktionspotenzials (gestörte Repolarisation im Ischämiegebiet)

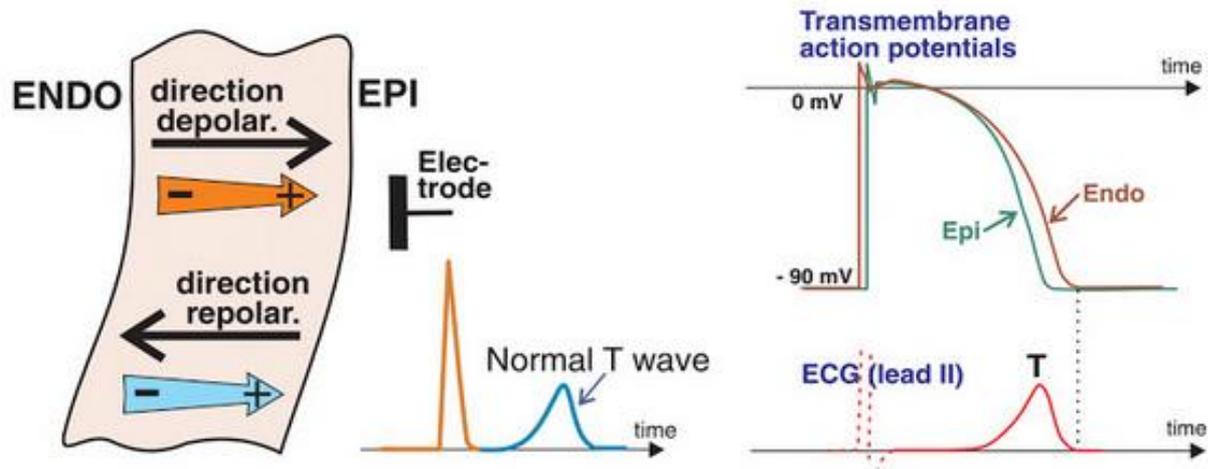


EKG: Normale Repolarisation

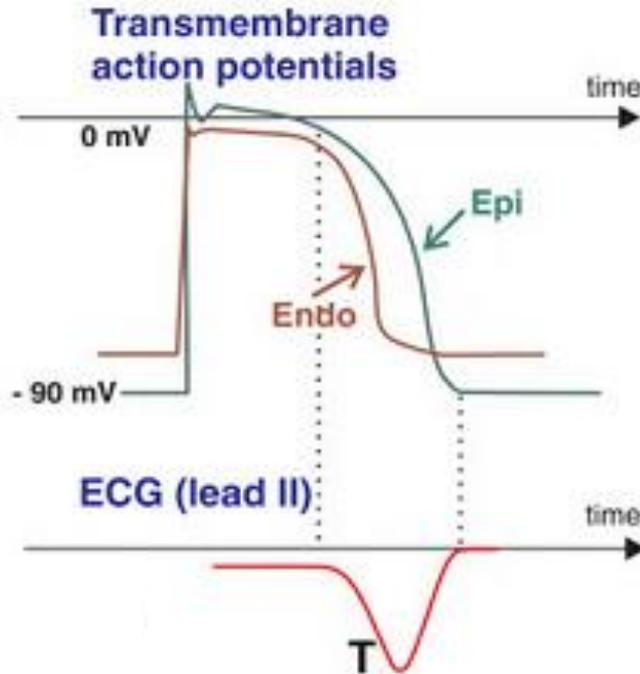


- Die Aktionspotenzialdauer ist endokardial länger als epikardial
- Während das Endokard noch erregt ist (negativ), hat sich die Erregung epikardial bereits zurückgebildet (positiv)
- Es fließt ein Strom von endokardial (-) nach epikardial (+)
- Die T-Welle ist positiv (Vektor ist auf die registrierende Elektrode hingerrichtet)

EKG: Normale Repolarisation

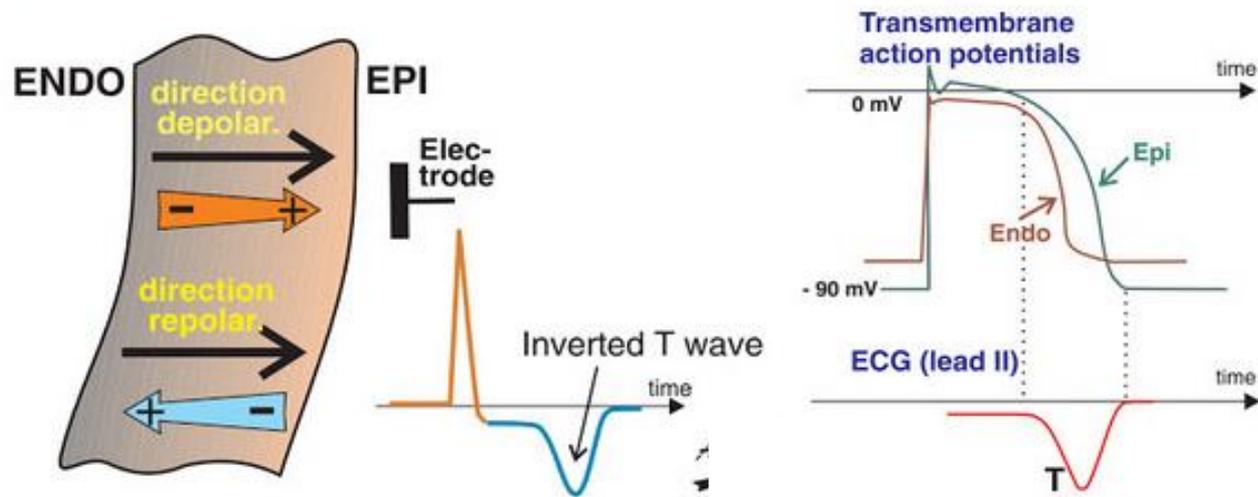


EKG: Subendokardiale Ischämie



- Bei subendokardialer Ischämie resultiert eine Verkürzung der endokardialen Aktionspotenzialdauer
- Während das Epikard noch erregt ist (negativ), hat sich die Erregung endokardiale bereits zurückgebildet (positiv).
- Es fließt ein Strom von epikardial (-) nach endokardial (+)
- Die T-Welle ist negativ (Vektor ist von der registrierende Elektrode weggerichtet)

EKG: Subendokardiale Ischämie



Belastungs-induzierte Ischämie

Ruhe

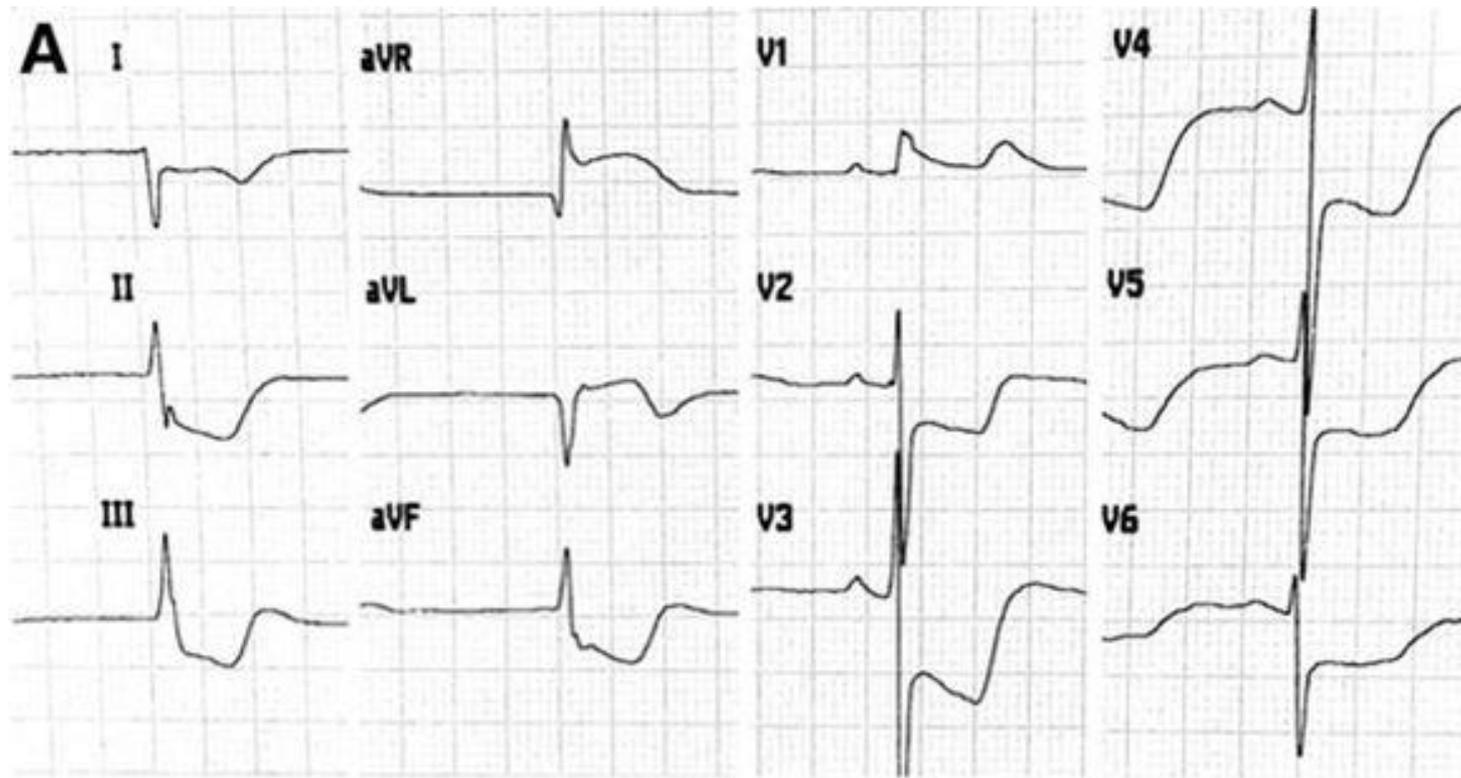


Belastung



- Sensitivität ist abhängig von der Ableitung (höchste Sensitivität, wenn linkspräkordial (V4-V6) nachweisbar)
- Verteilung erlaubt kein Lokalisation der Ischämie!

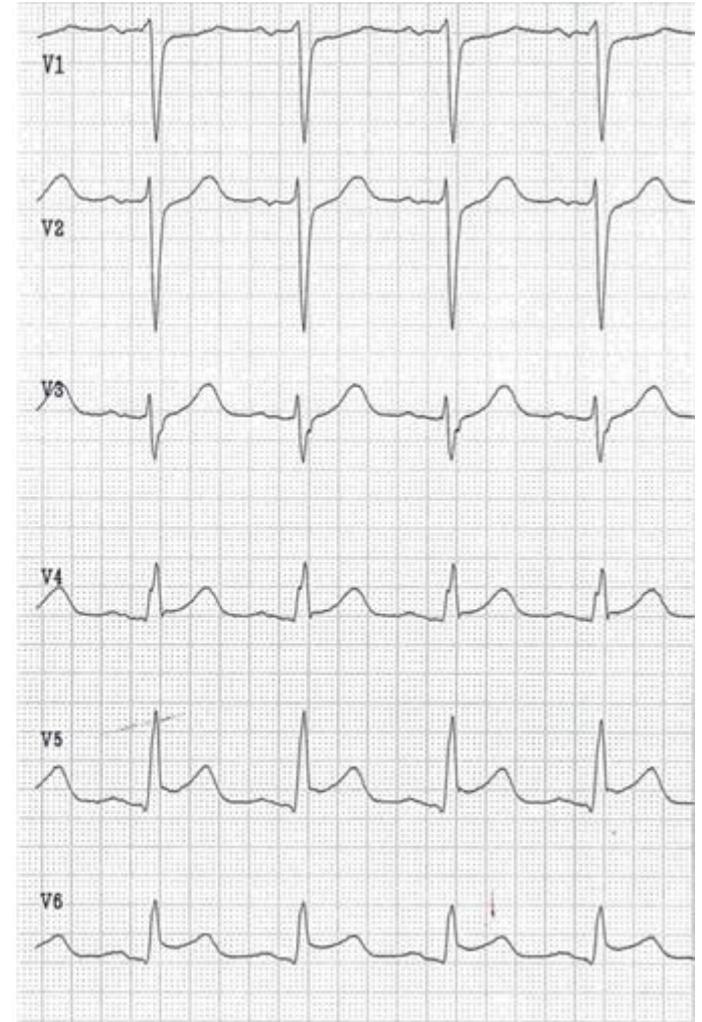
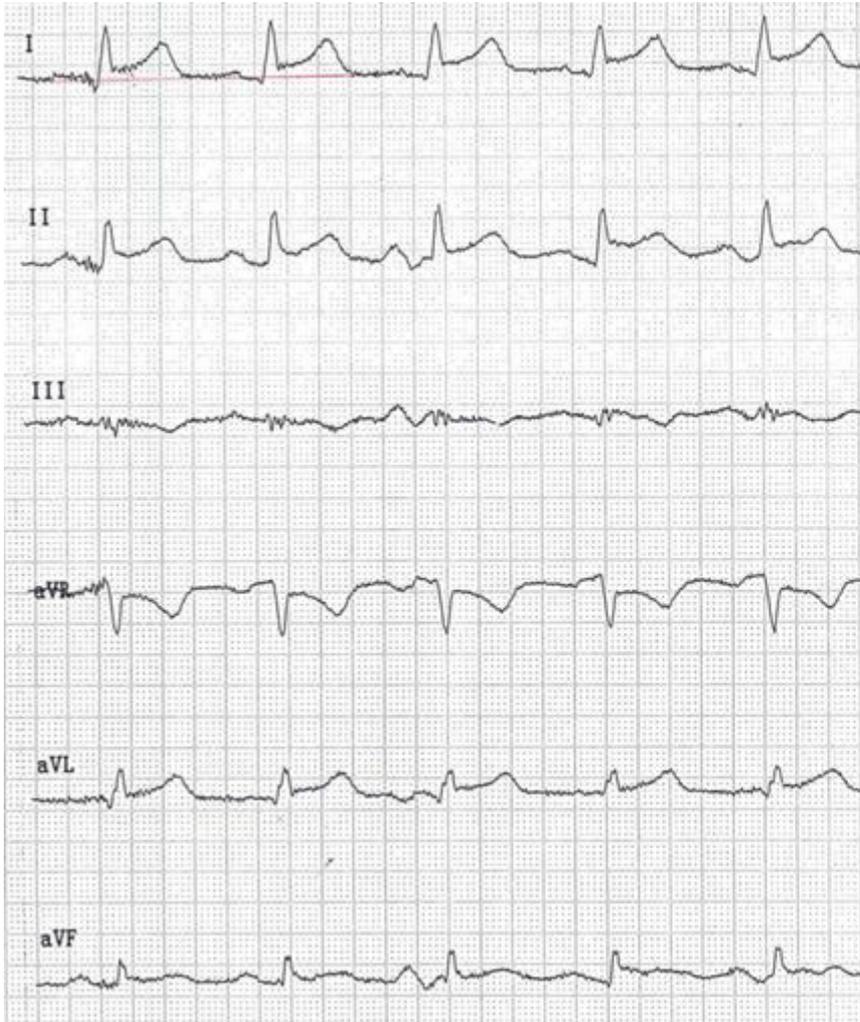
Case: LCM-Stenose



EKG: Ischämie und Myokardinfarkt

- **Ischämie (ischemia)**
- **Verletzung (injury)**
- **Nekrose (necrosis)**

Akuter Vorderwandinfarkt (ST-Hebungsinfarkt)



EXPERT CONSENSUS DOCUMENT

Third Universal Definition of Myocardial Infarction

Kristian Thygesen, Joseph S. Alpert, Allan S. Jaffe, Maarten L. Simoons, Bernard R. Chaitman and Harvey D. White: the Writing Group on behalf of the Joint ESC/ACCF/AHA/WHF Task Force for the Universal Definition of Myocardial Infarction

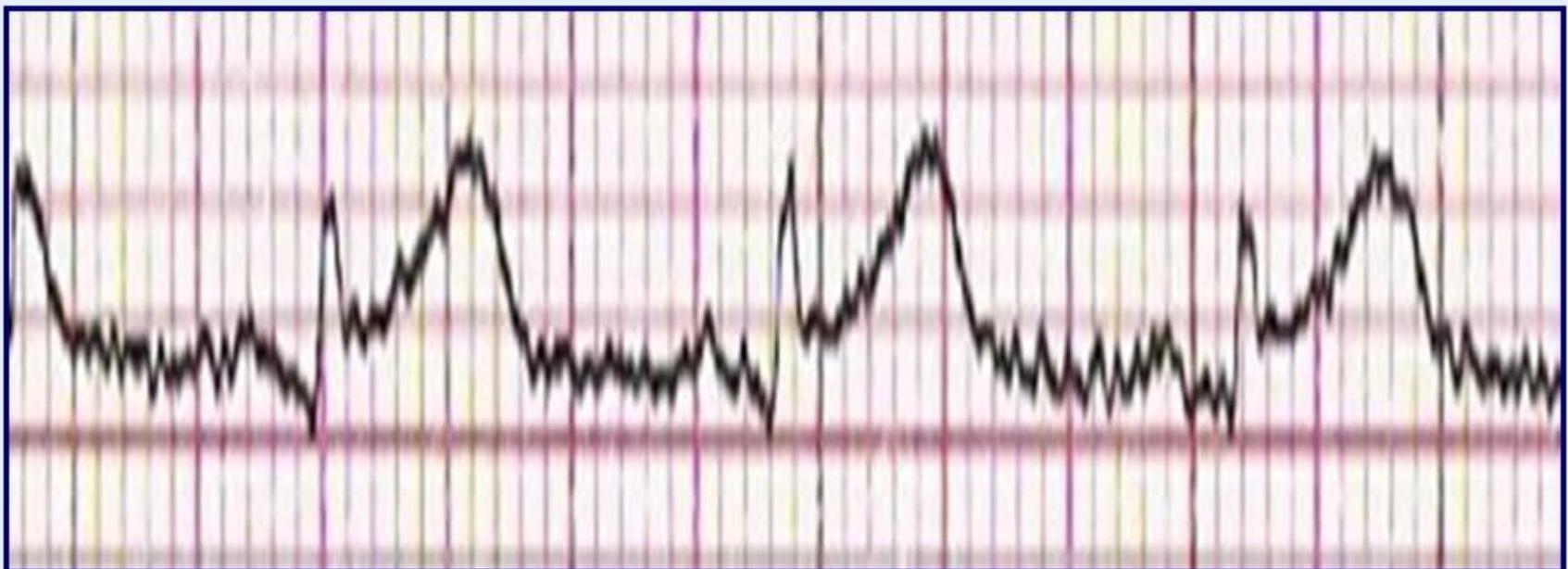
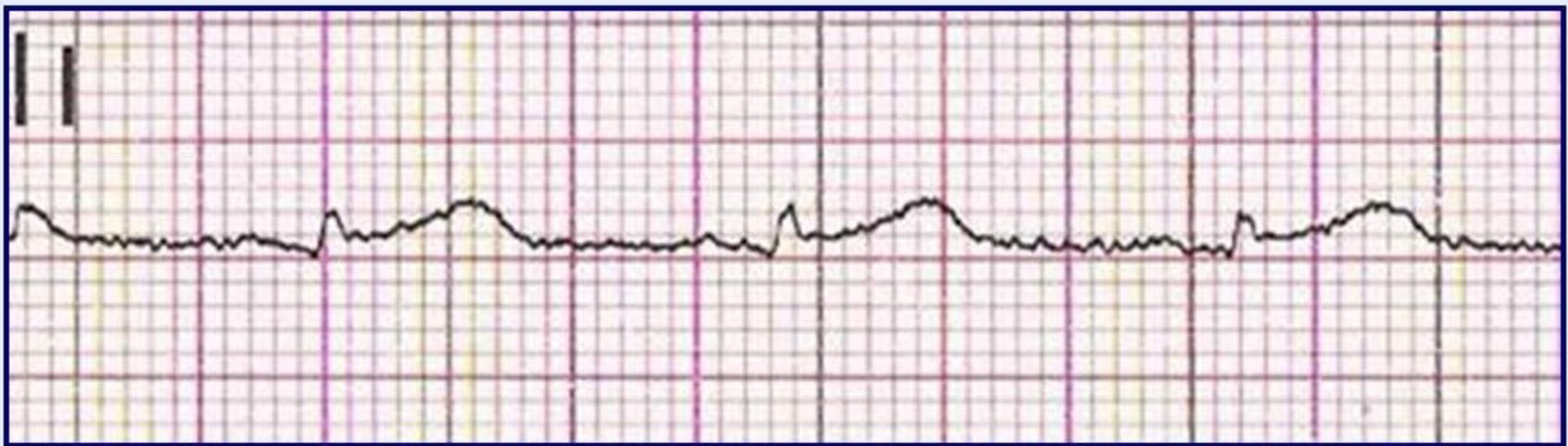
Table 3. ECG Manifestations of Acute Myocardial Ischemia (in Absence of LVH and LBBB)

ST elevation

New ST elevation at the J point in two contiguous leads with the cut-points:
 ≥ 0.1 mV in all leads other than leads V_2 - V_3 where the following cut points apply: ≥ 0.2 mV in men ≥ 40 years; ≥ 0.25 mV in men < 40 years, or ≥ 0.15 mV in women.

ST depression and T wave changes

New horizontal or down-sloping ST depression ≥ 0.05 mV in two contiguous leads and/or T inversion ≥ 0.1 mV in two contiguous leads with prominent R wave or R/S ratio > 1 .



EKG: Ischämie und Myokardinfarkt

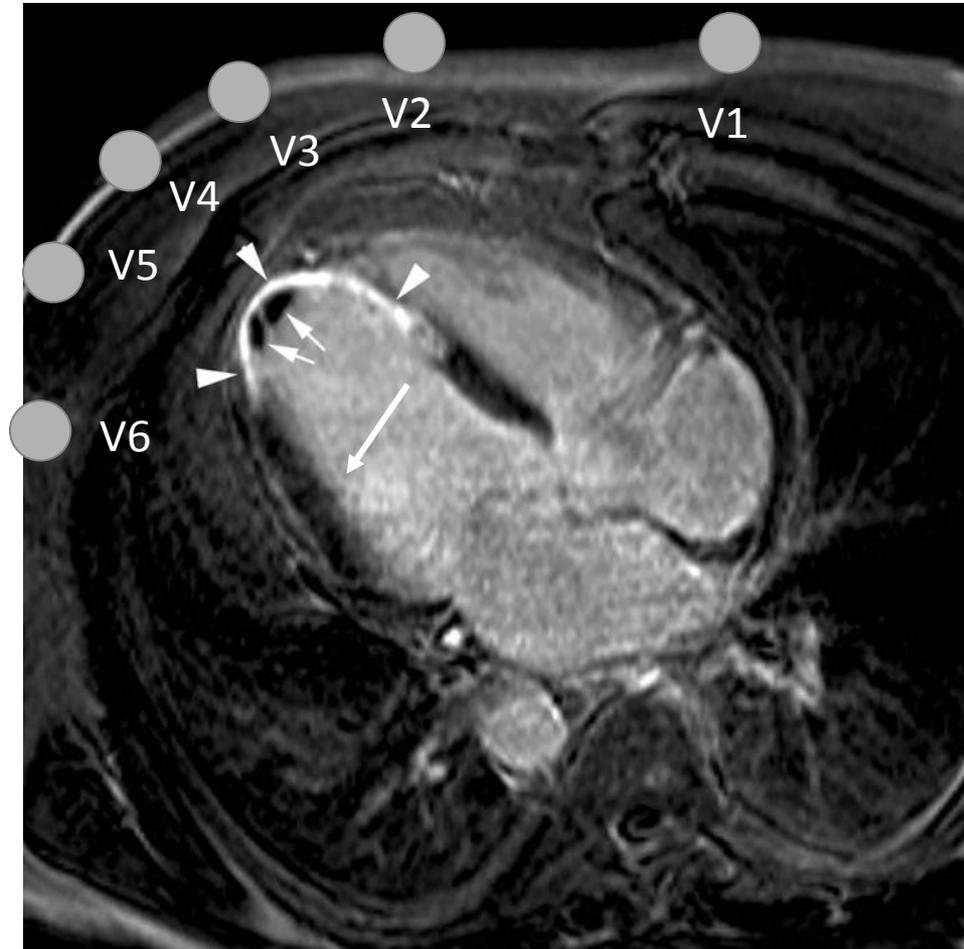
- **Ischämie (ischemia)**
- **Verletzung (injury)**
- **Nekrose (necrosis)**

Blick in den Kopf hinein ...

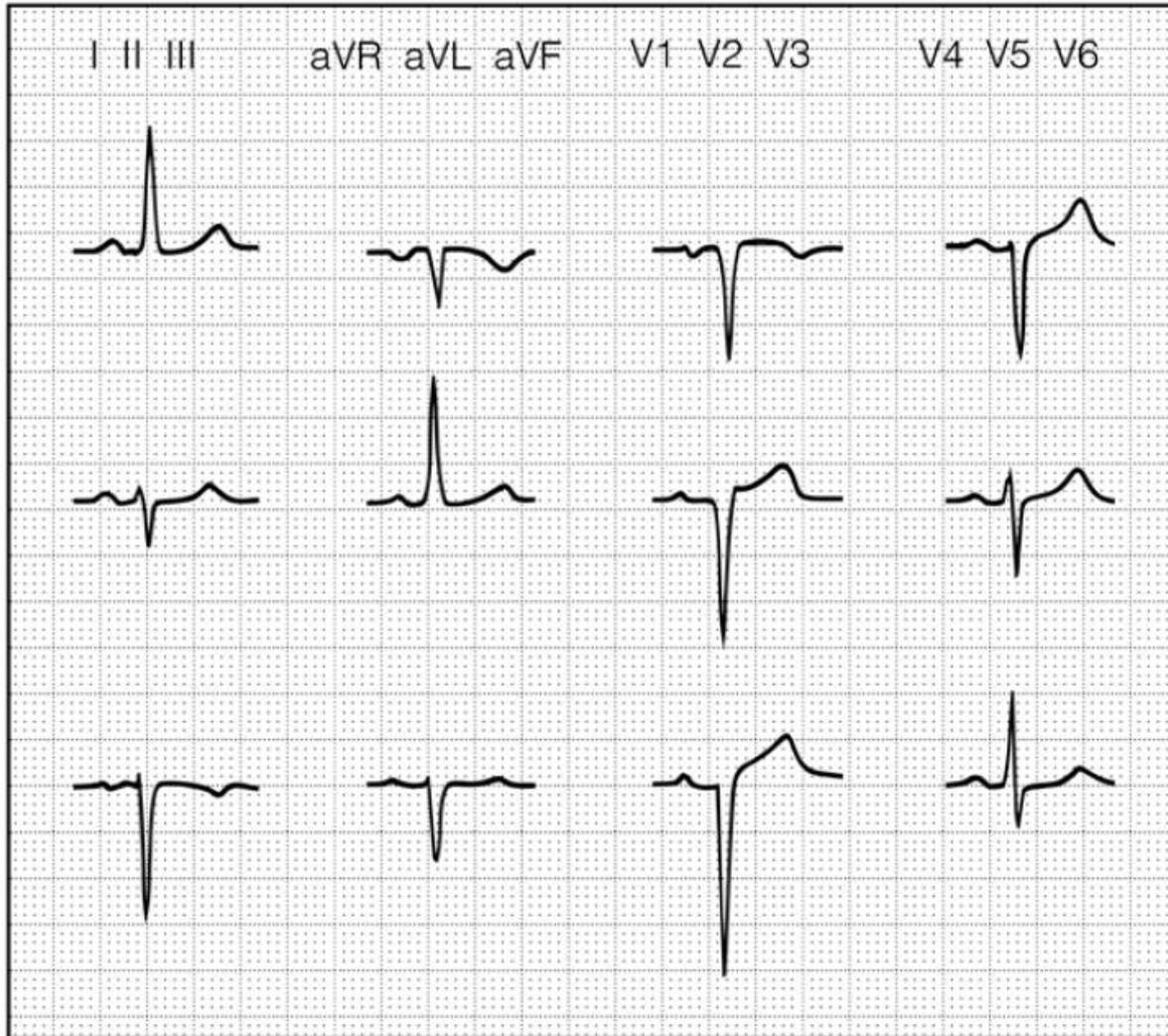


Alter ausgedehnter Vorderwandinfarkt

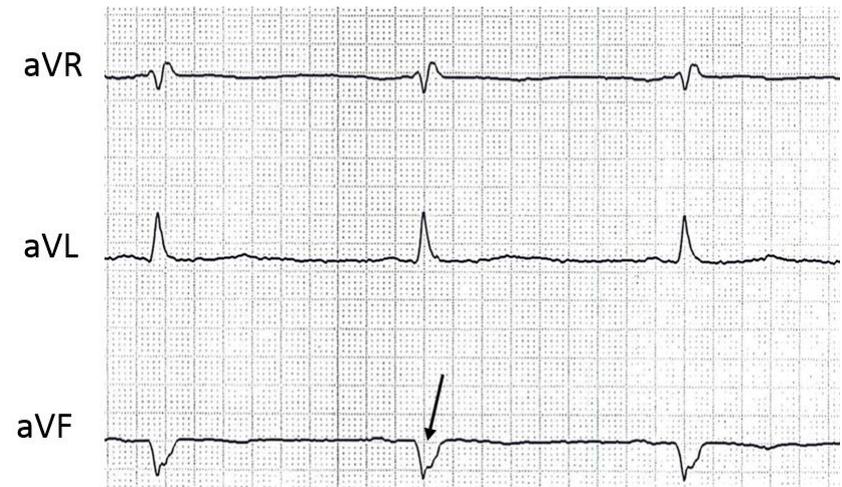
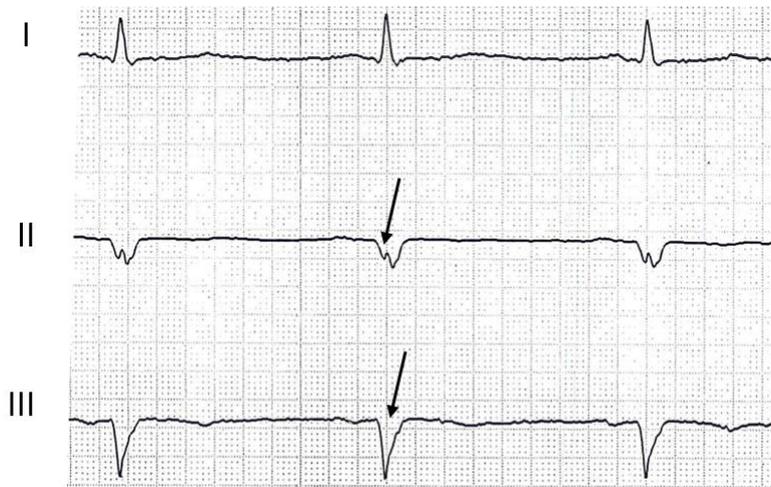
- Ein **Vektor** ist durch Betrag und Richtung definiert



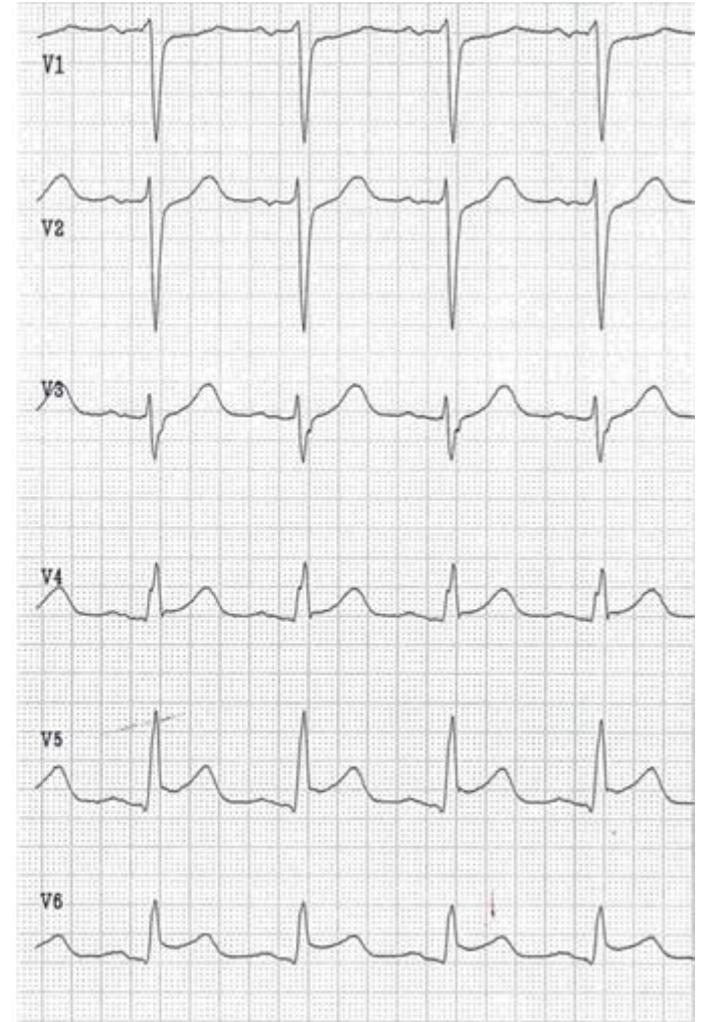
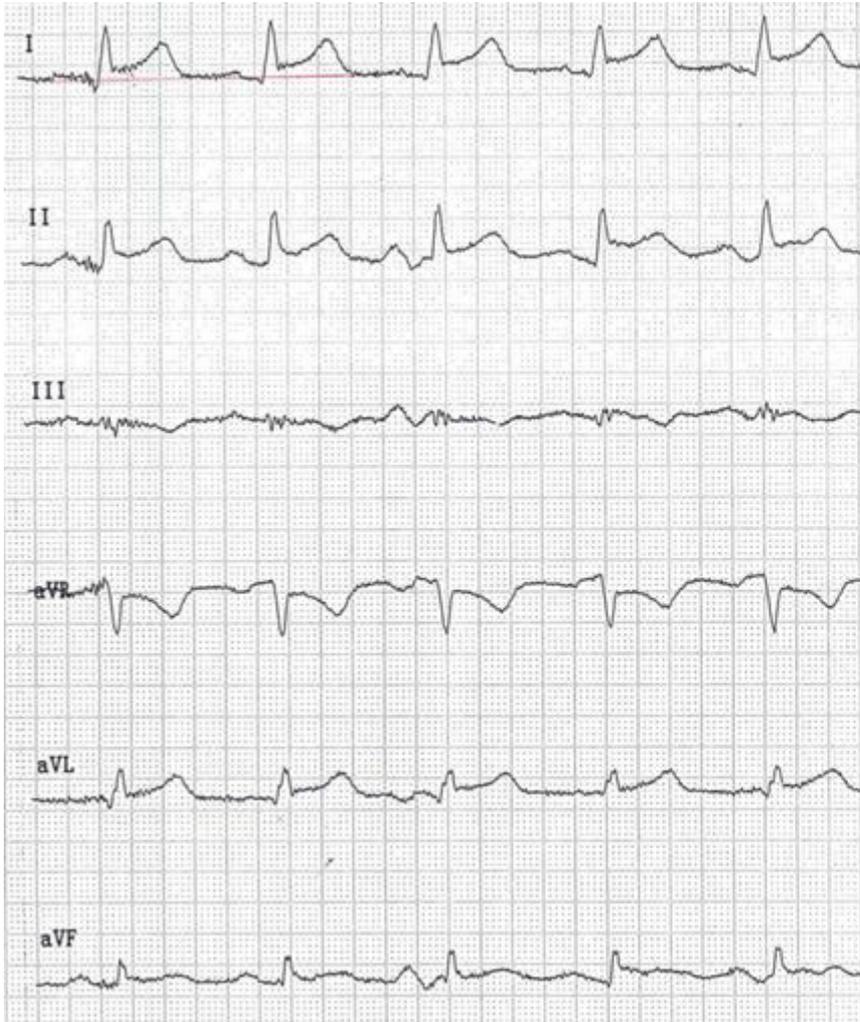
Alter Vorderwandinfarkt



Alter Hinterwandinfarkt

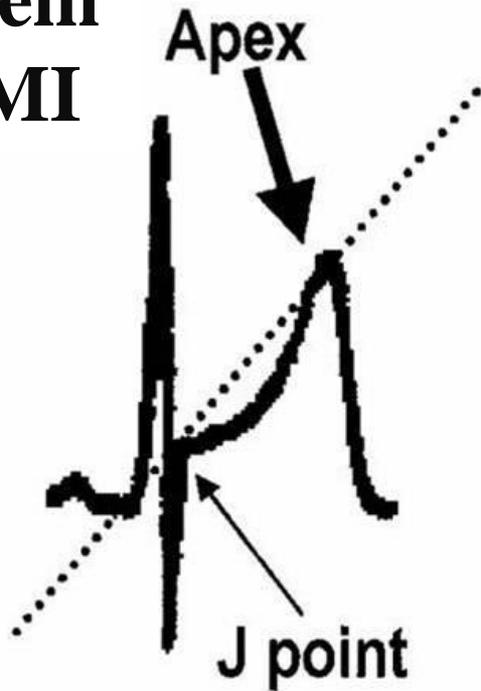


Akuter Vorderwandinfarkt (ST-Hebungsinfarkt)



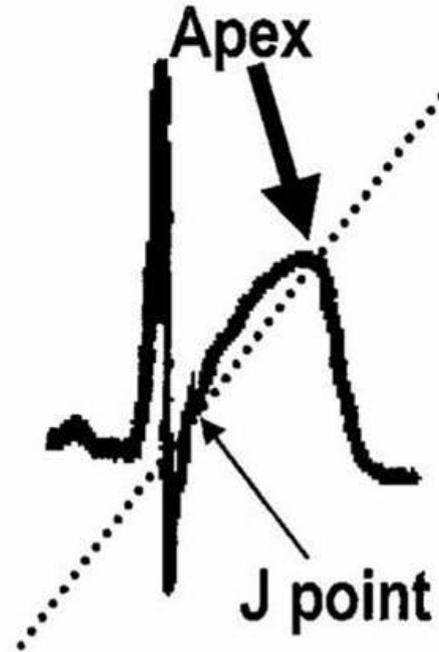
ST-Verlauf (bzw. –Morphologie)

**Kein
MI**

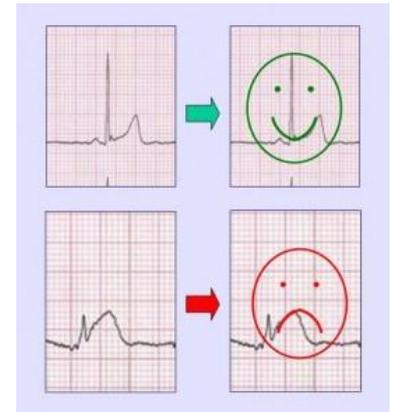


Concave

MI



Non-concave



EMS12lead.com

Bardy et al. 2001

Nicht-AMI-ST-Hebung: Wie häufig?

- *Brady et al., Cause of ST segment abnormality in ED chest pain patients (Am J Emerg Med 2001 Jan;19(1):25-8)*
- Retrospective review of ED charts over 3-month period
- Looked at 902 adults with cc "chest pain"
- Looked for STE in contiguous leads, >1mm limb leads, >2mm precordials
- Compared final diagnoses, MI vs. other

Nicht-AMI-ST-Hebung: Wie häufig?

Results

- Only 15% of STE patients had MI!
- **85% had non-MI diagnosis**

Nicht-AMI-ST-Hebung: Ursachen?

- Left Ventricular Hypertrophy — 25%
- Left Bundle Branch Block — 15%
- **AMI — 15%**
- Benign Early Repolarization — 12%
- Right Bundle Branch Block — 5%
- Nonspecific BBB — 5%
- Ventricular aneurysm — 3%
- Pericarditis — 1%
- Undefined/unknown — 17%

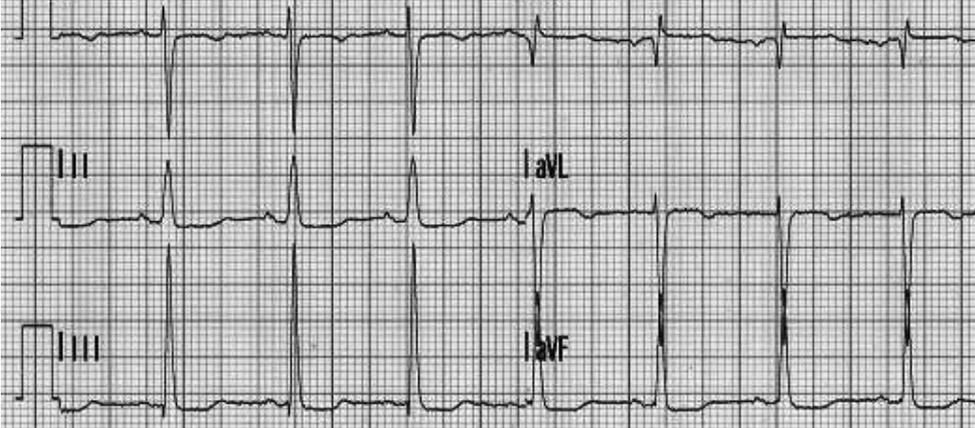
ST-Hebung: Diagnostisches Vorgehen

EKG-Zeichen, die auf einen AMI hinweisen

Signifikante ST-Hebung in zusammenhängenden Ableitungen (mit spiegelbildlichen Veränderungen), Dynamik und passender Klinik!

- **Signifikant** bedeutet: ST-Amplitude relativ zur R-Amplitude!
- **Zusammenhängend** bedeutet: Die Verteilung der ST-Hebung in den Ableitungen macht Sinn!
- **Dynamik** bedeutet: EKG-Veränderungen im kurzzeitigen Verlauf!

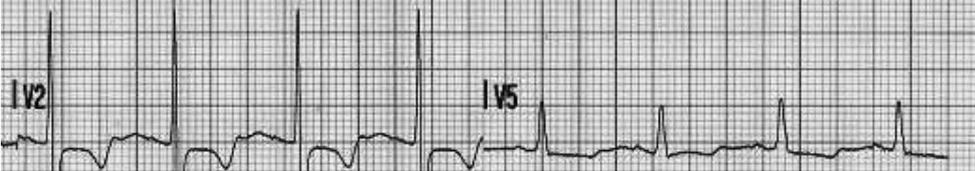
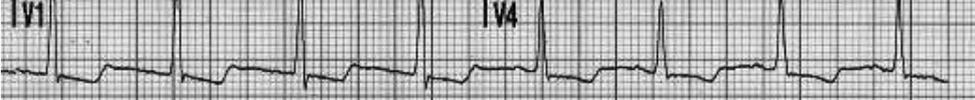
Name: [REDACTED] **12-Lead 3** **HR 91 bpm**
ID: [REDACTED] **12:55:29**
Patient ID: [REDACTED] **PR 0.130s** **QRS 0.088s**
Incident: [REDACTED] **QT/QTc** **0.338s/0.415s**
Age: 16 **Sex:** [REDACTED] **P-QRS-T Axes** **63° 121° 258°**
aVR

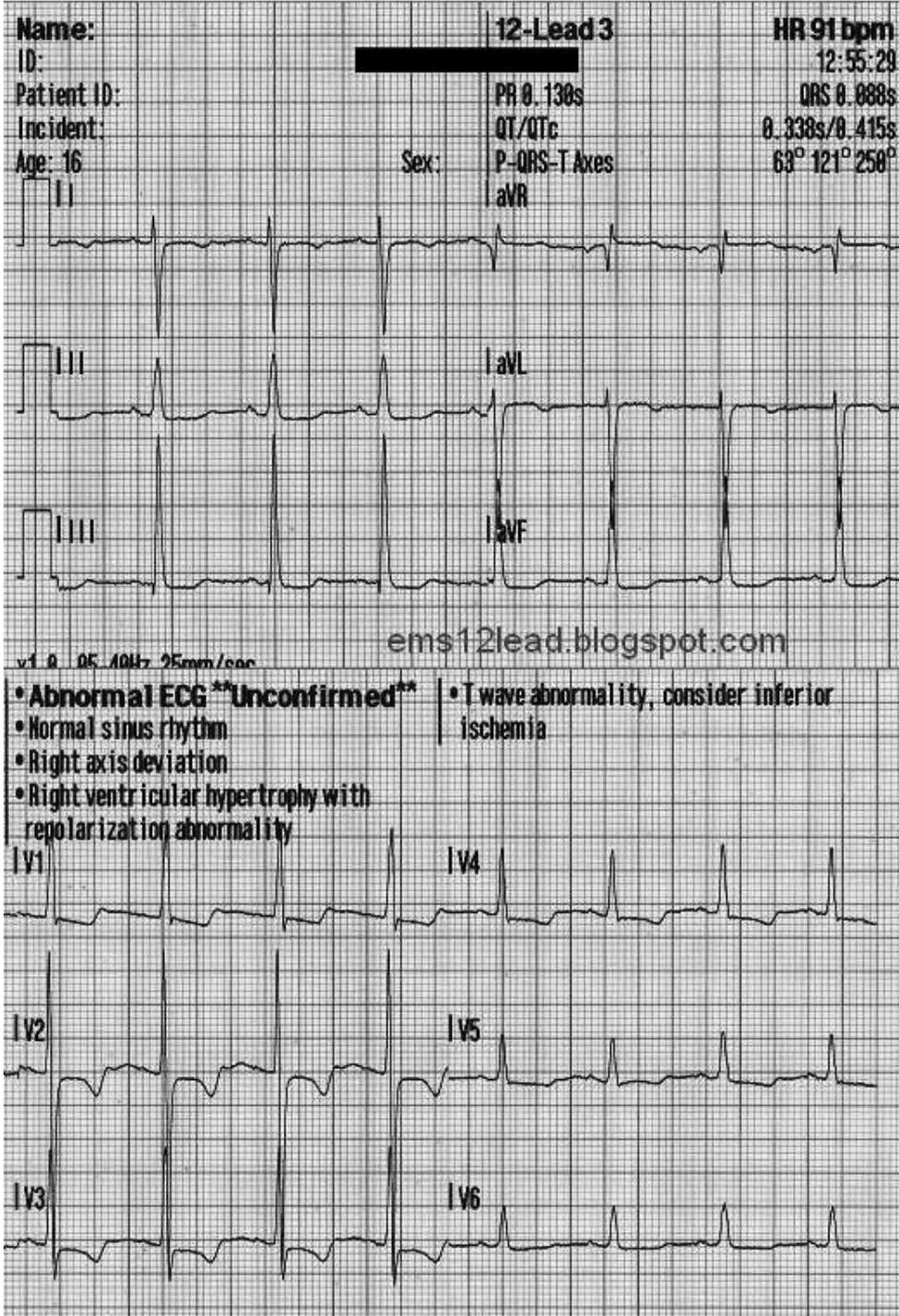


ems12lead.blogspot.com

v1 0.05 10Hz 25mm/sec

- **Abnormal ECG**Unconfirmed****
- Normal sinus rhythm
- Right axis deviation
- Right ventricular hypertrophy with repolarization abnormality
- T wave abnormality, consider inferior ischemia





- RVH

RVH

Bei typischen Beschwerden und negativem T in V1-V3 sollte lt. Leitlinie 2017 eine Registrierung der posterioren Ableitungen erfolgen.

Name:

ID:

Patient ID:

Incident:

Age: 44

[Redacted]

12-Lead 1

HR 77 bpm

14:08:23

PR 0.222s

QRS 0.092s

QT/QTc

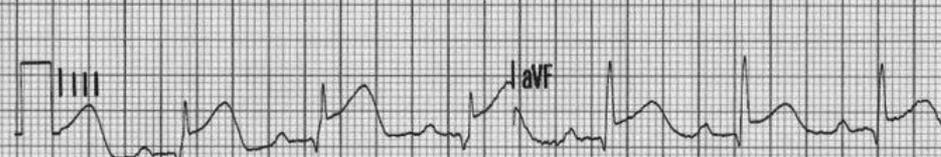
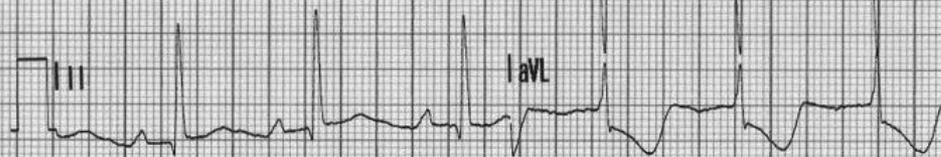
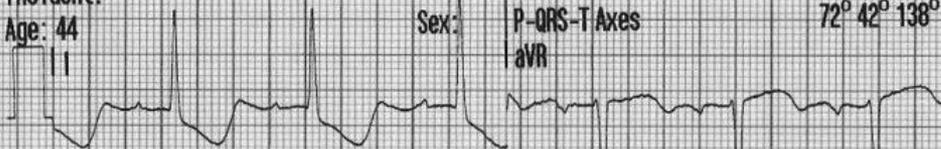
0.404s/0.457s

P-QRS-T Axes

72° 42° 138°

Sex:

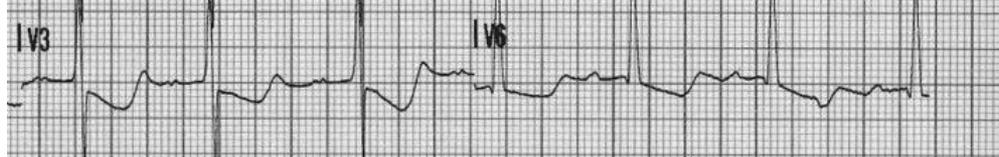
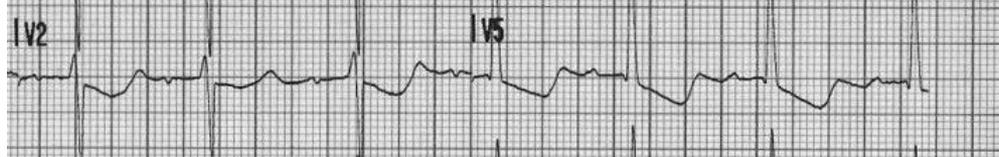
aVR

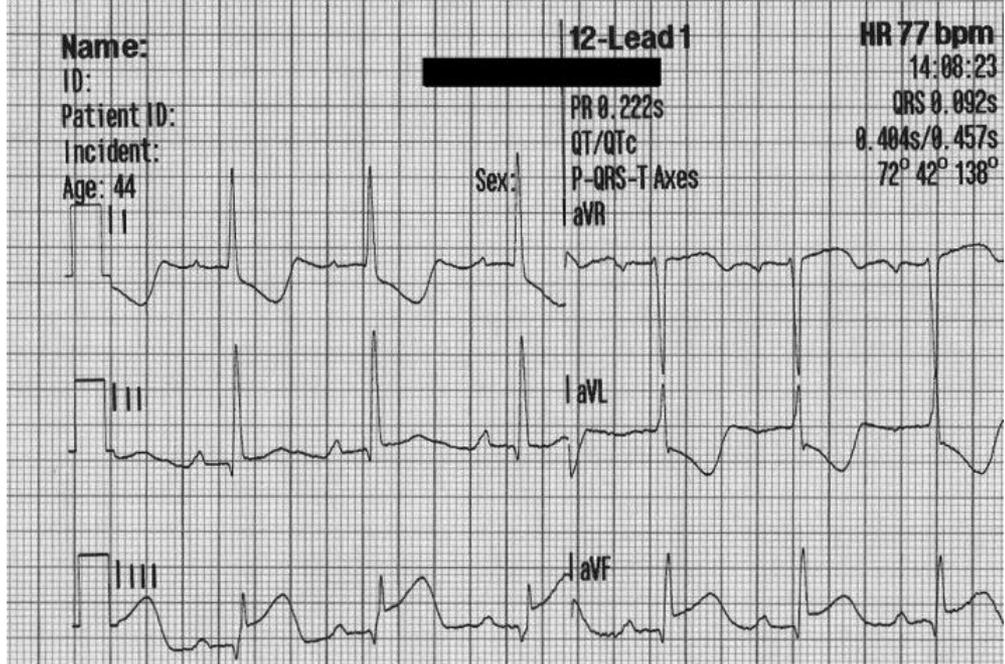


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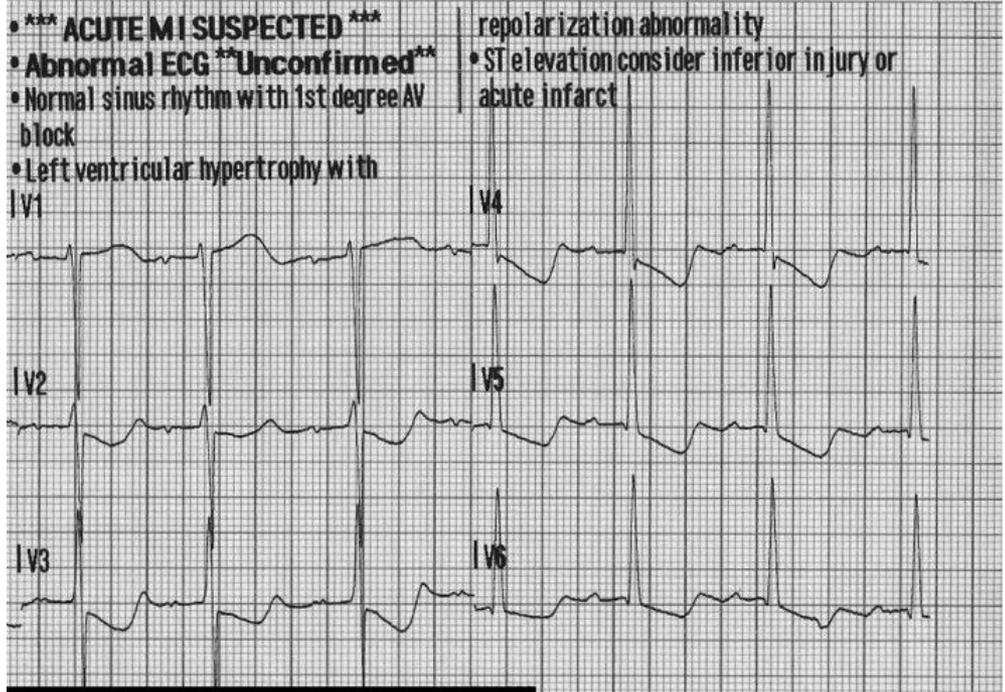
- ***** ACUTE MI SUSPECTED *****
- **Abnormal ECG **Unconfirmed****
- Normal sinus rhythm with 1st degree AV block
- Left ventricular hypertrophy with

- repolarization abnormality
- ST elevation consider inferior injury or acute infarct



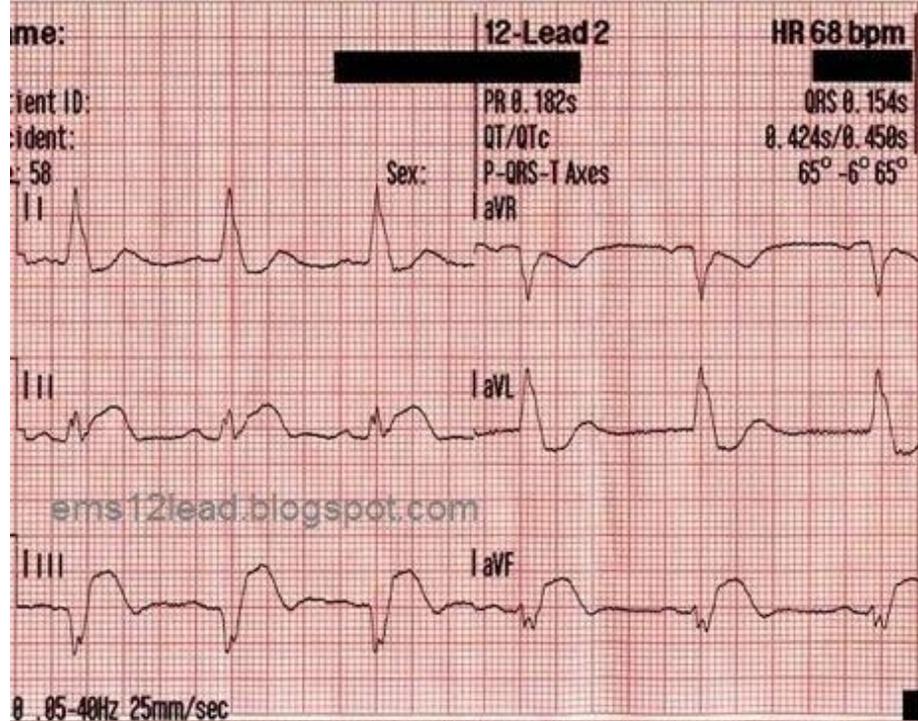


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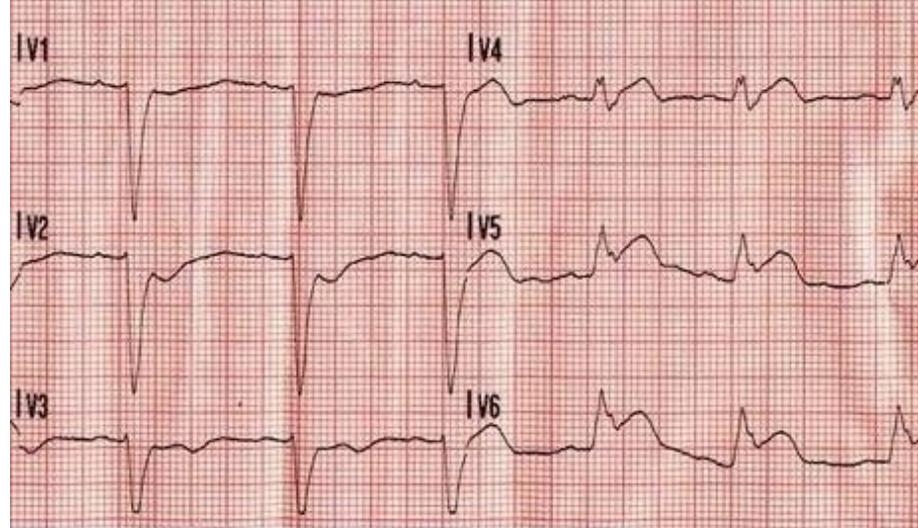
- LVH
- ST-Hebung in III, aVF (und II)
- ST-Senkung in I, aVL, V2-V4

Inferiorer MI bei RCA-Verschluss und Zeichen der LVH

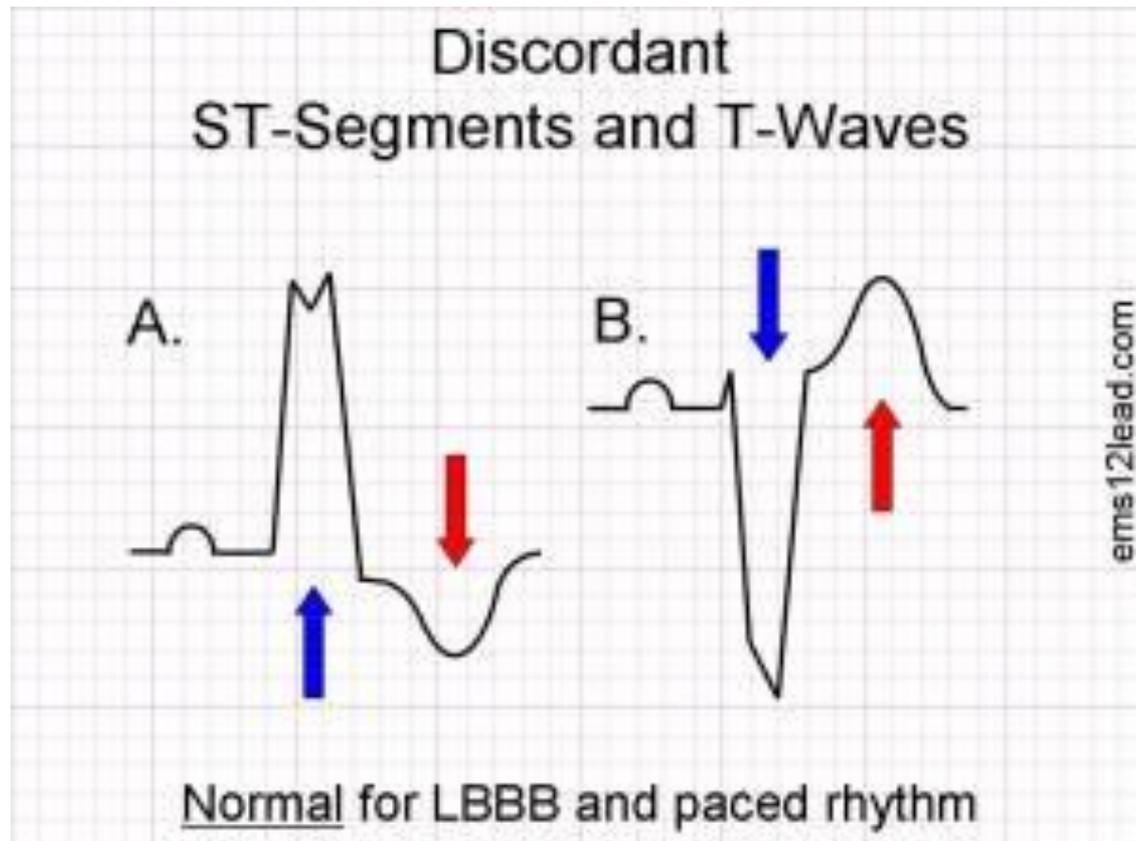


• **Abnormal ECG ^{**}Unconfirmed^{**}**

- Normal sinus rhythm with sinus arrhythmia
- Left bundle branch block



Normaler LSB



AMI bei LSB: Sgarbossa-Kriterien

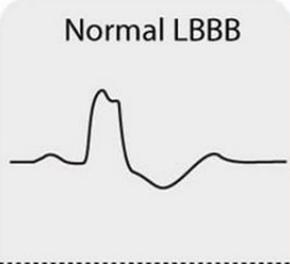
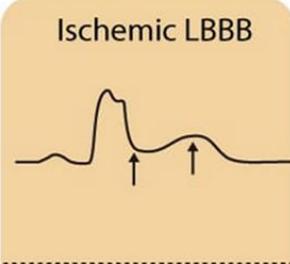
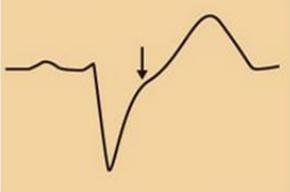
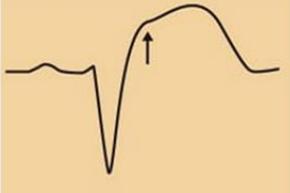
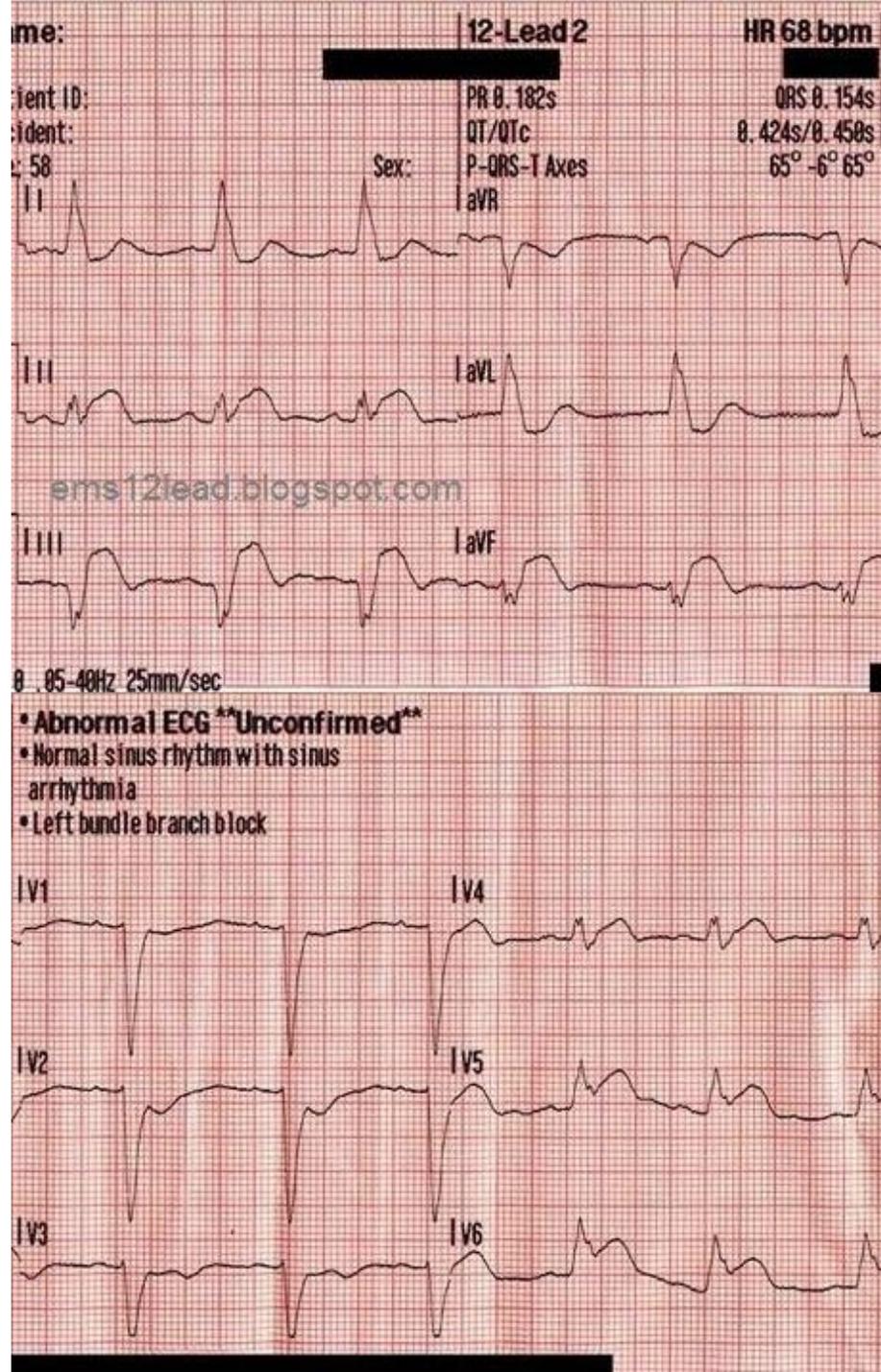
		Sgarbossa criteria for diagnosis of STEMI in the setting of LBBB	
Criteria	Points	Normal LBBB	Ischemic LBBB
ST segment elevation ≥ 1 mm in any lead with positive QRS (V4, V5, V6, aVL, I).	5	V4-V6, aVL, I 	
ST segment depression ≥ 1 mm in V1, V2 and/or V3.	3	V1-V3 	
ST segment elevation ≥ 5 mm in any lead with discordant QRS (V1, V2, V3)	2	V1-V3 	
		These complexes show the normal (expected) appearance of LBBB.	These complexes show ischemic manifestations in the setting of LBBB.

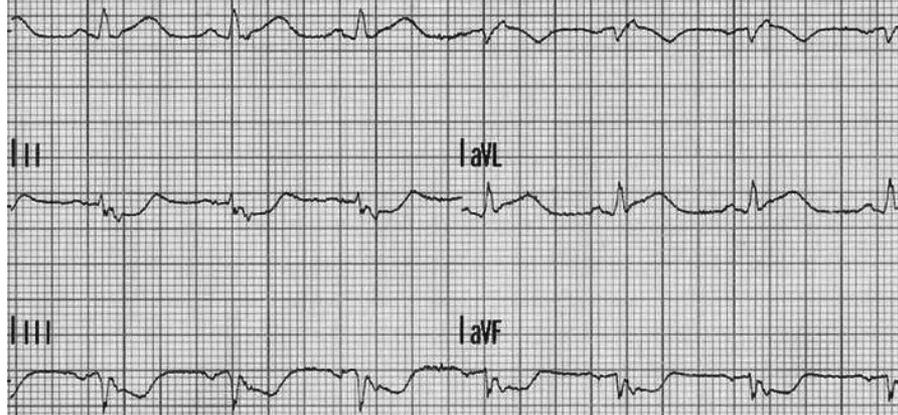
Figure 1. ECG criteria (Sgarbossa criteria) for acute STEMI in the setting of LBBB. Each criteria gives 2 to 5 points. Studies show that a cut-off of ≥ 3 points yields a sensitivity of 20–36% and specificity of 90–98% for acute STEMI in the setting of LBBB.

- LSB
- ST-Hebung in II, V5 und V6
- ST-Senkung V1 – V3
- Exzessive Diskordanz in III und aVF

Inferoposteriorer MI bei
LCX- und RCA-Verschluss und LSB

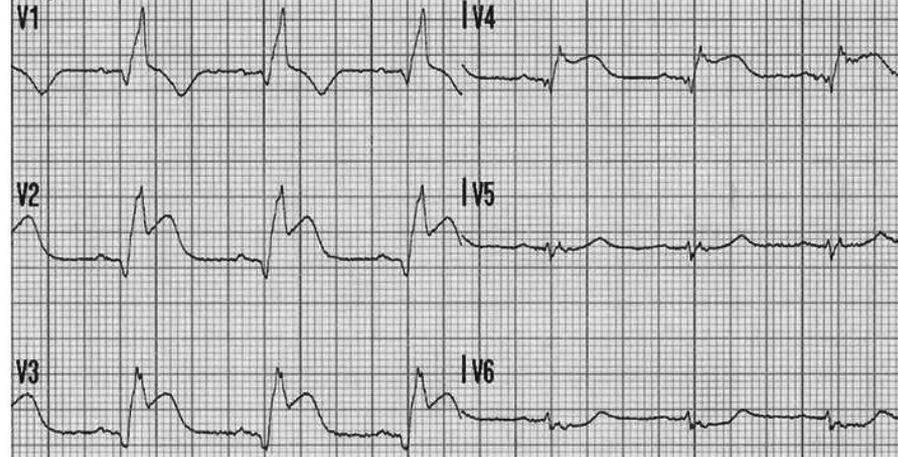


12-Lead 5 **HR 79 bpm**
 Patient ID: 08:06:55
 Patient Name: PR 0.134s
 77 QRS 0.152s
 Sex: QT/QTc
 P-QRS-T Axes 0.418s/0.479s
 aVR -14° -43° -18°



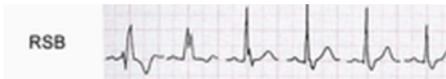
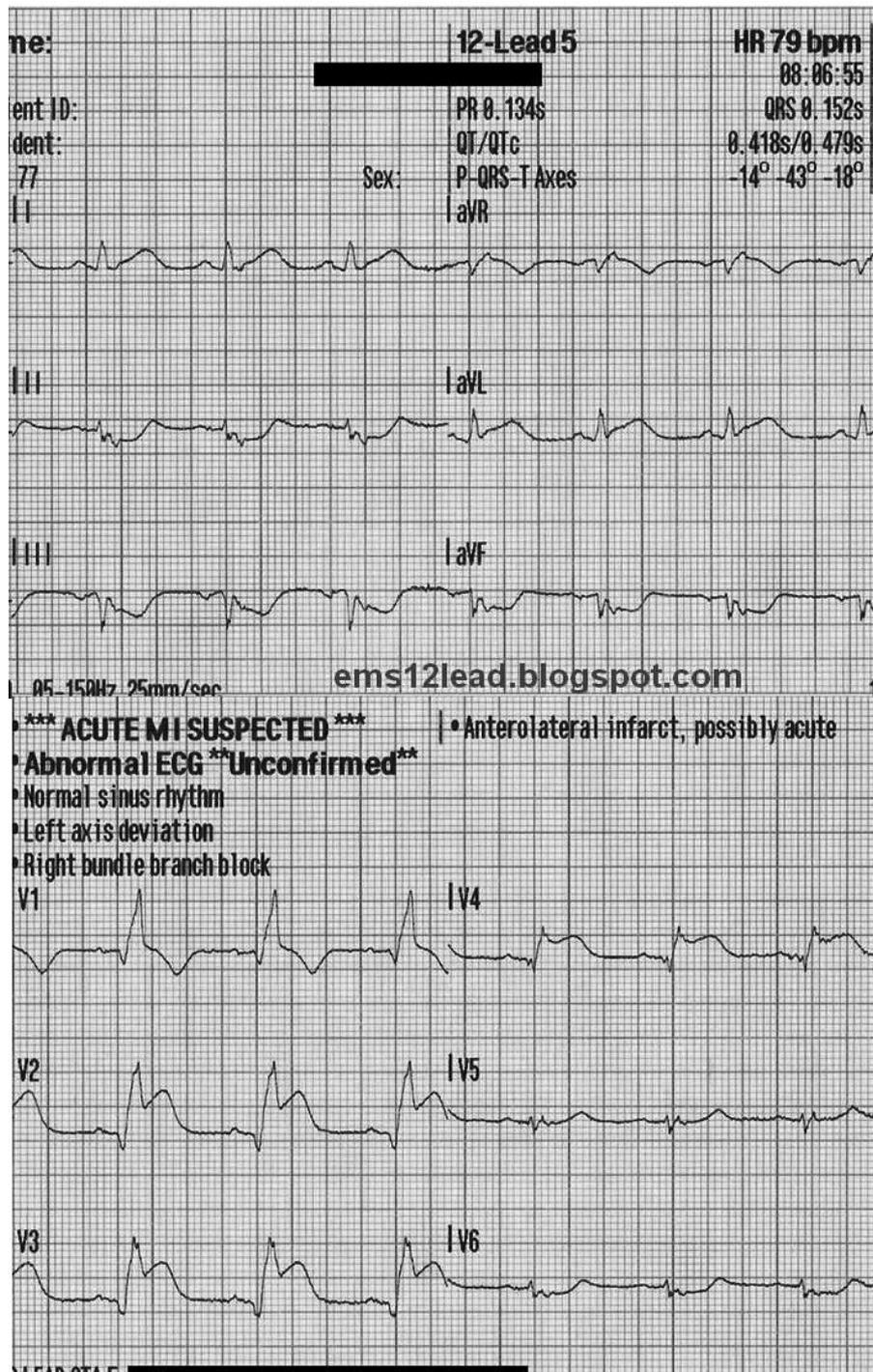
05-150Hz 25mm/sec ems12lead.blogspot.com

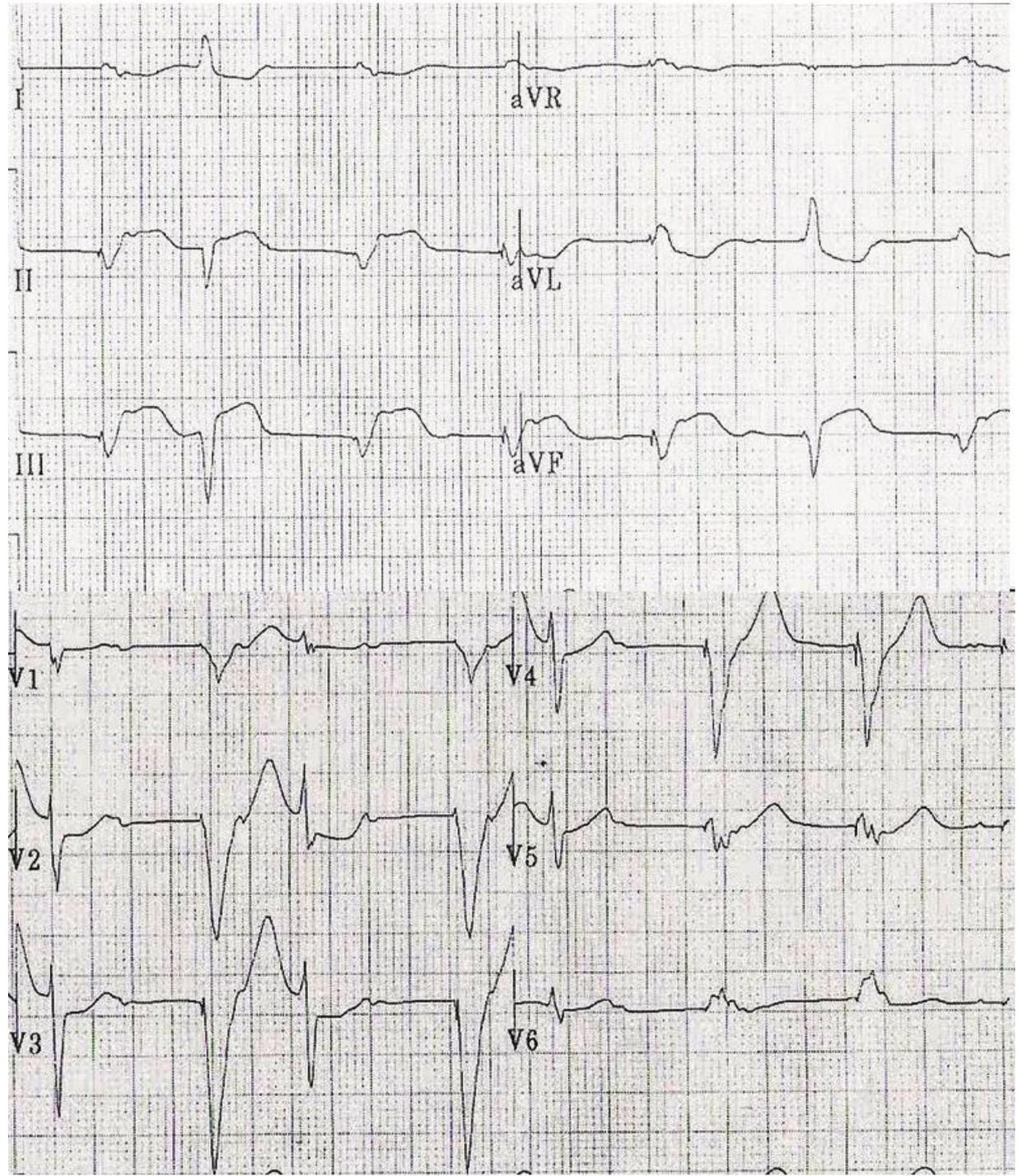
***** ACUTE MI SUSPECTED ***** • Anterolateral infarct, possibly acute
Abnormal ECG **Unconfirmed**
 • Normal sinus rhythm
 • Left axis deviation
 • Right bundle branch block



- RSB
- Konkordante ST-Hebung in I, V2-V4
- Konkordante ST-Senkung II, III und aVF

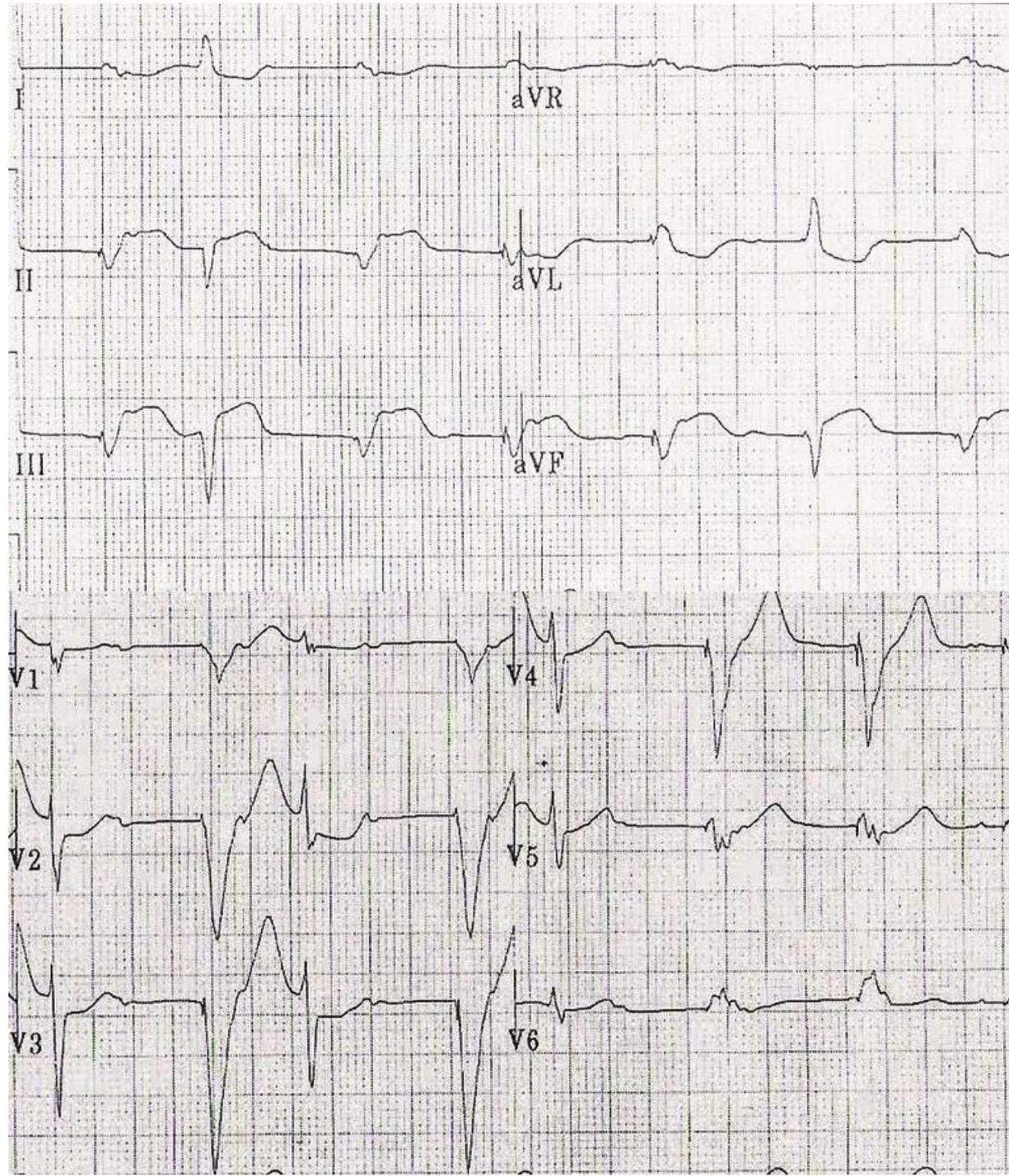
Anteriorer MI bei LAD-Verschluss und RSB

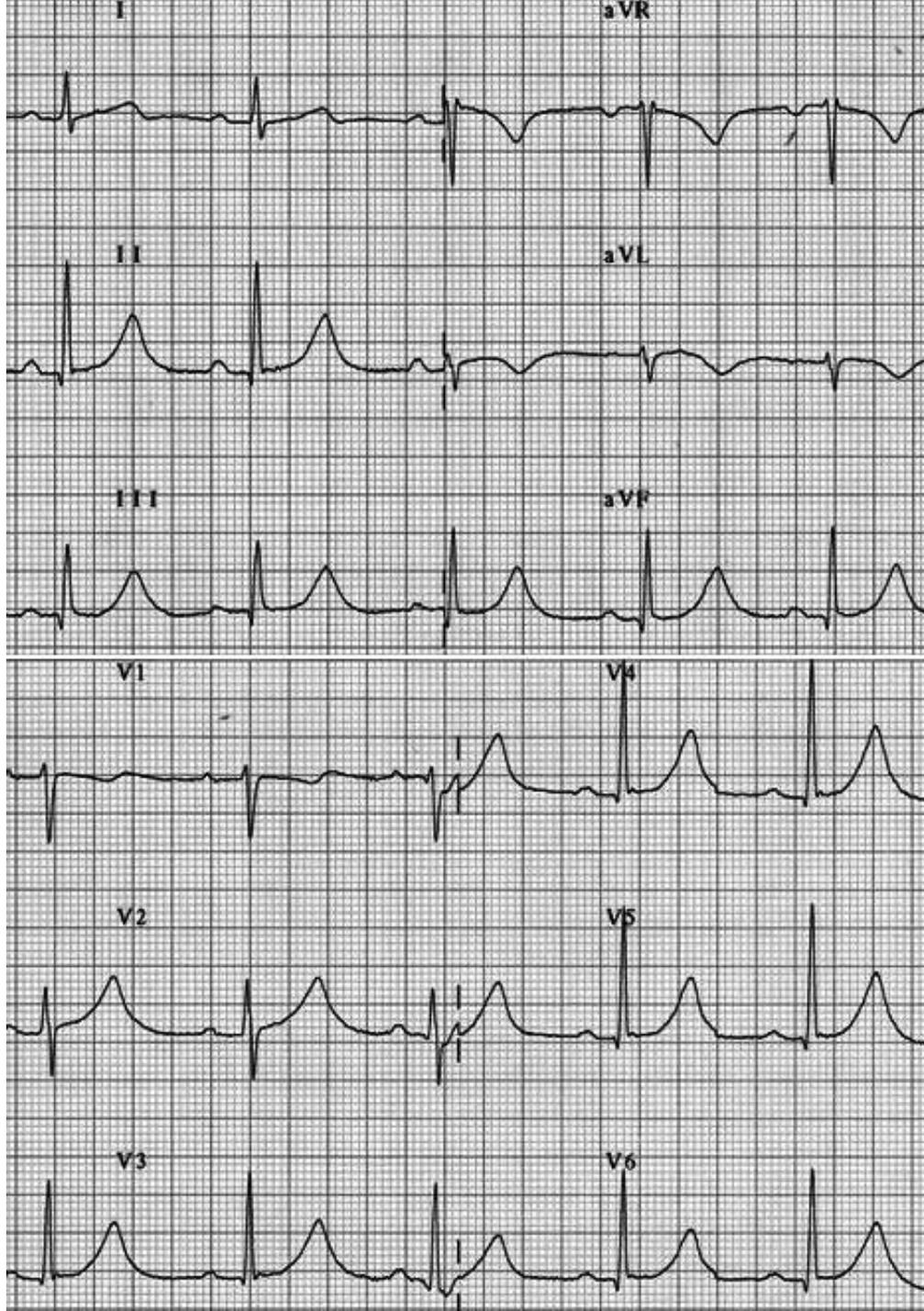




- VVI-Stimulation
- Diskordante ST-Hebung in II, III und aVF
- Diskordante ST-Senkung in aVL

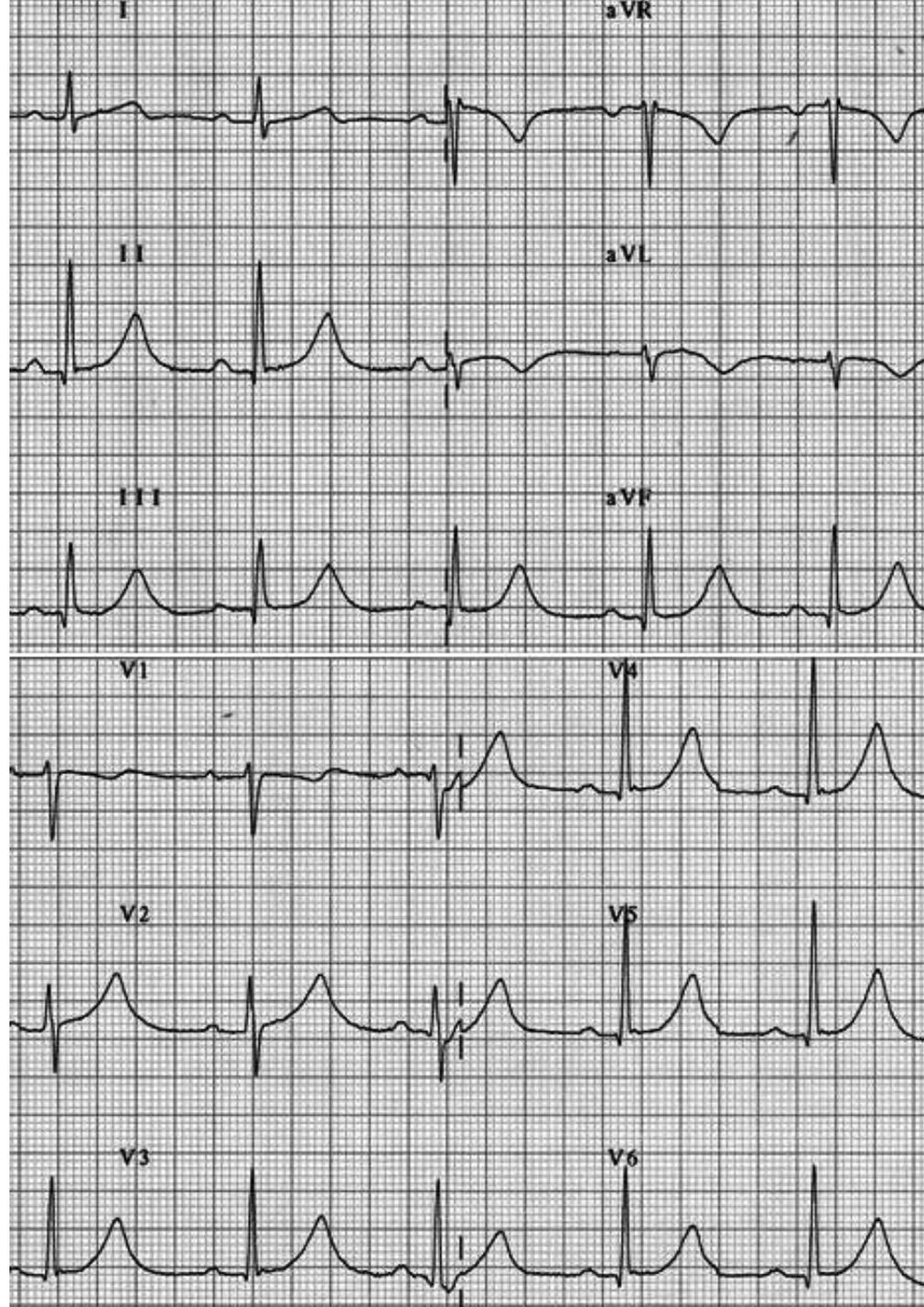
Inferiorere MI bei ventrikuläre Stimulation

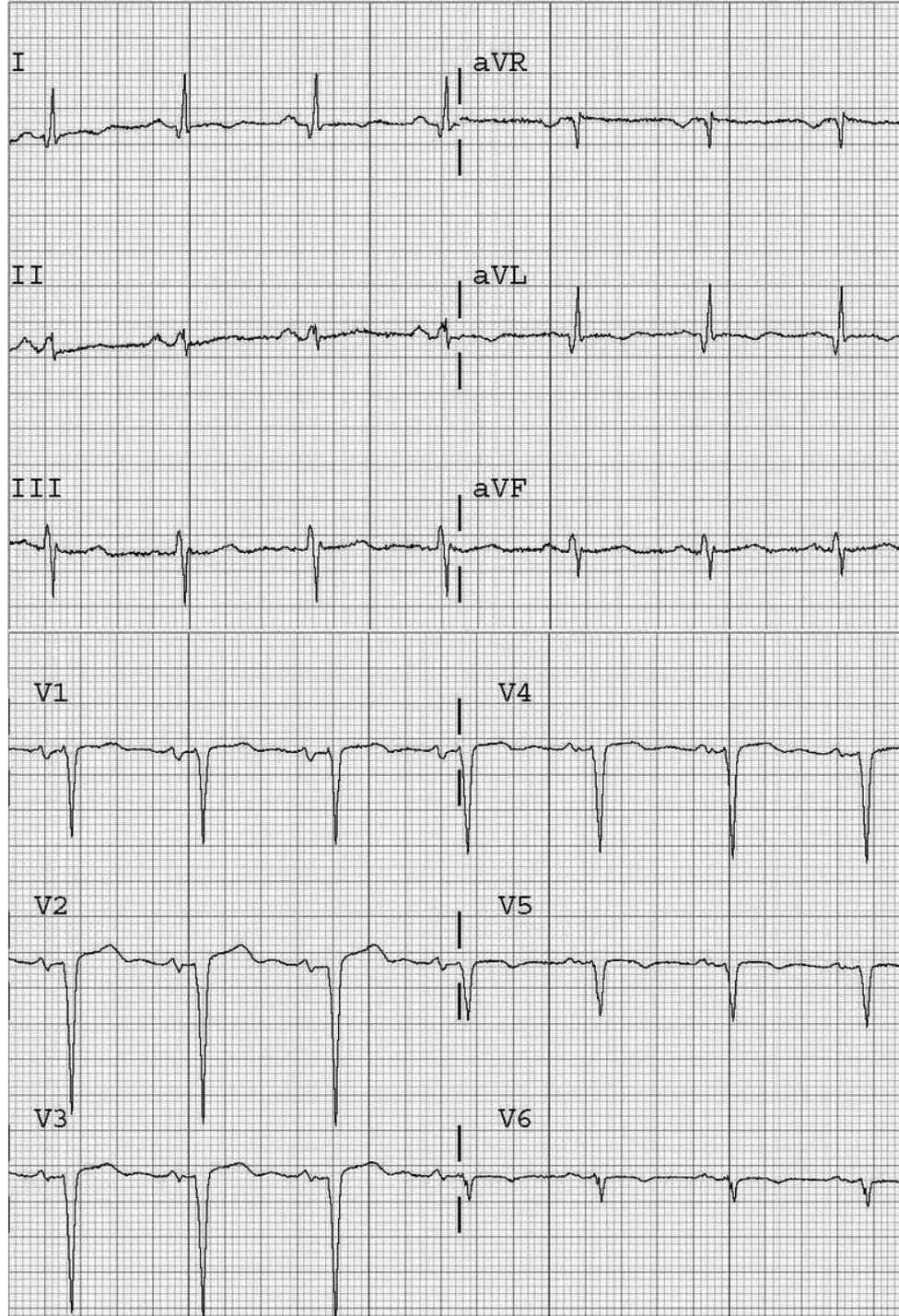




- Geringe ST-Hebung in V2-V4
- Breite und hohe T-Wellen

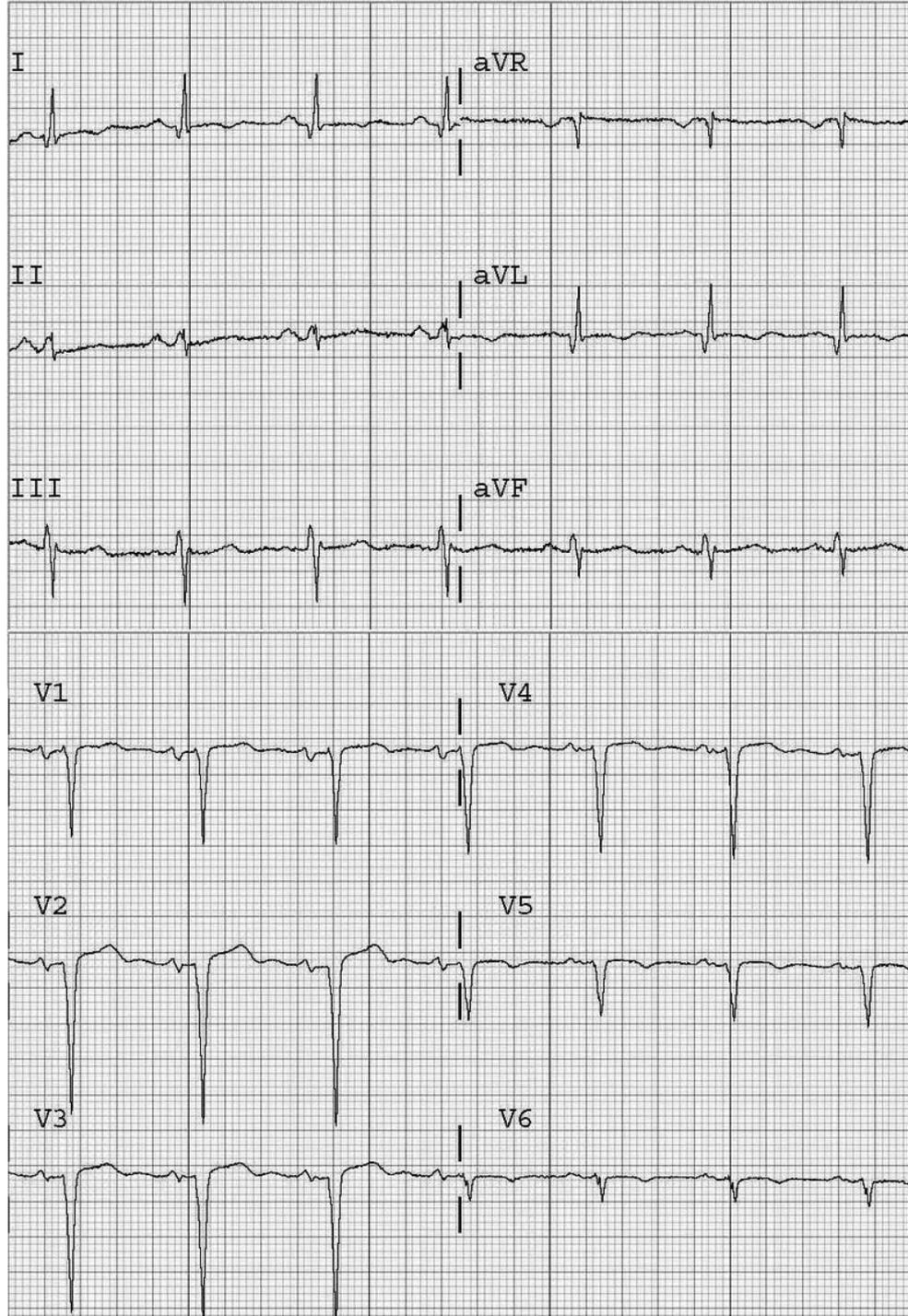
Frühe Repolarisation

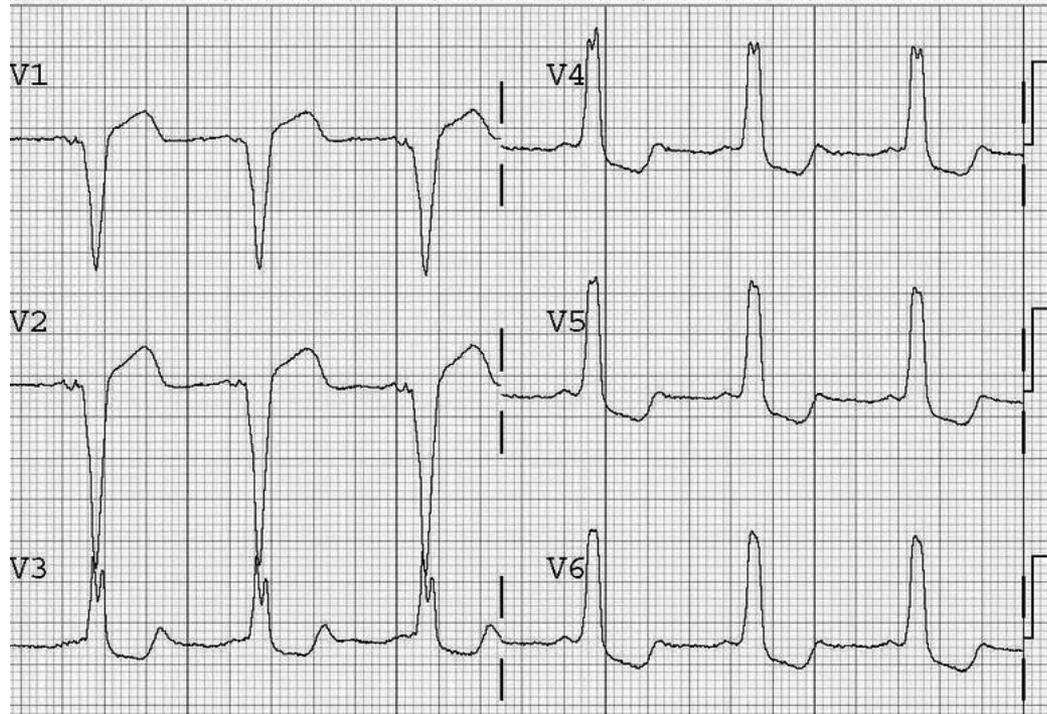
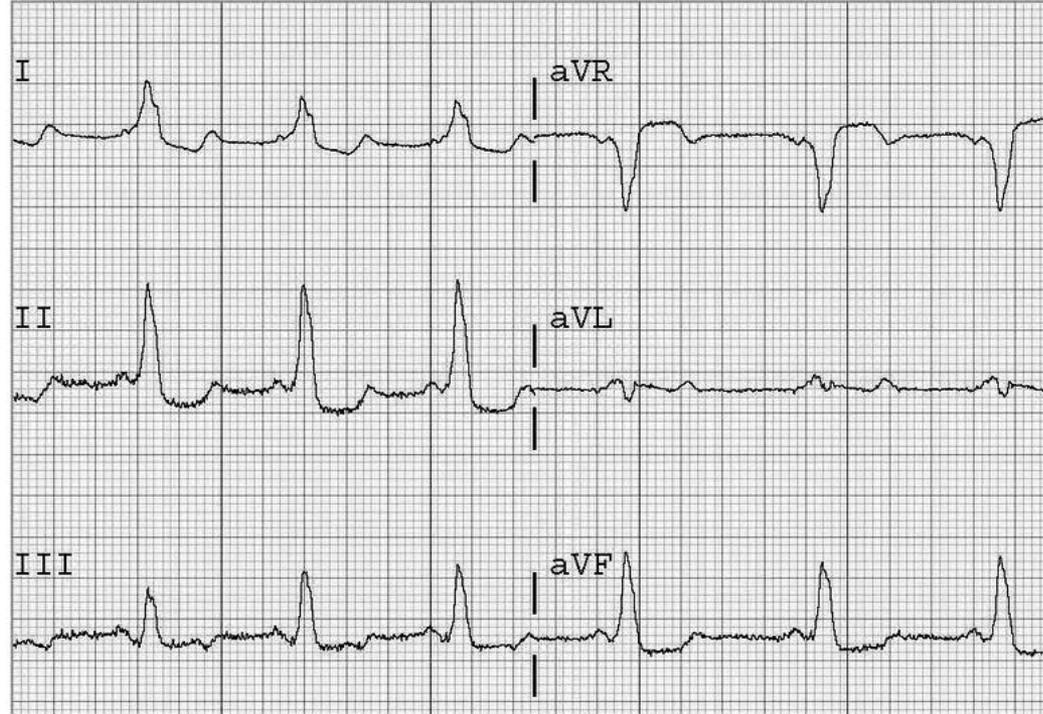




- Isoliert tiefe QS-Komplexe in V1-V4
- Normale T-Amplitude

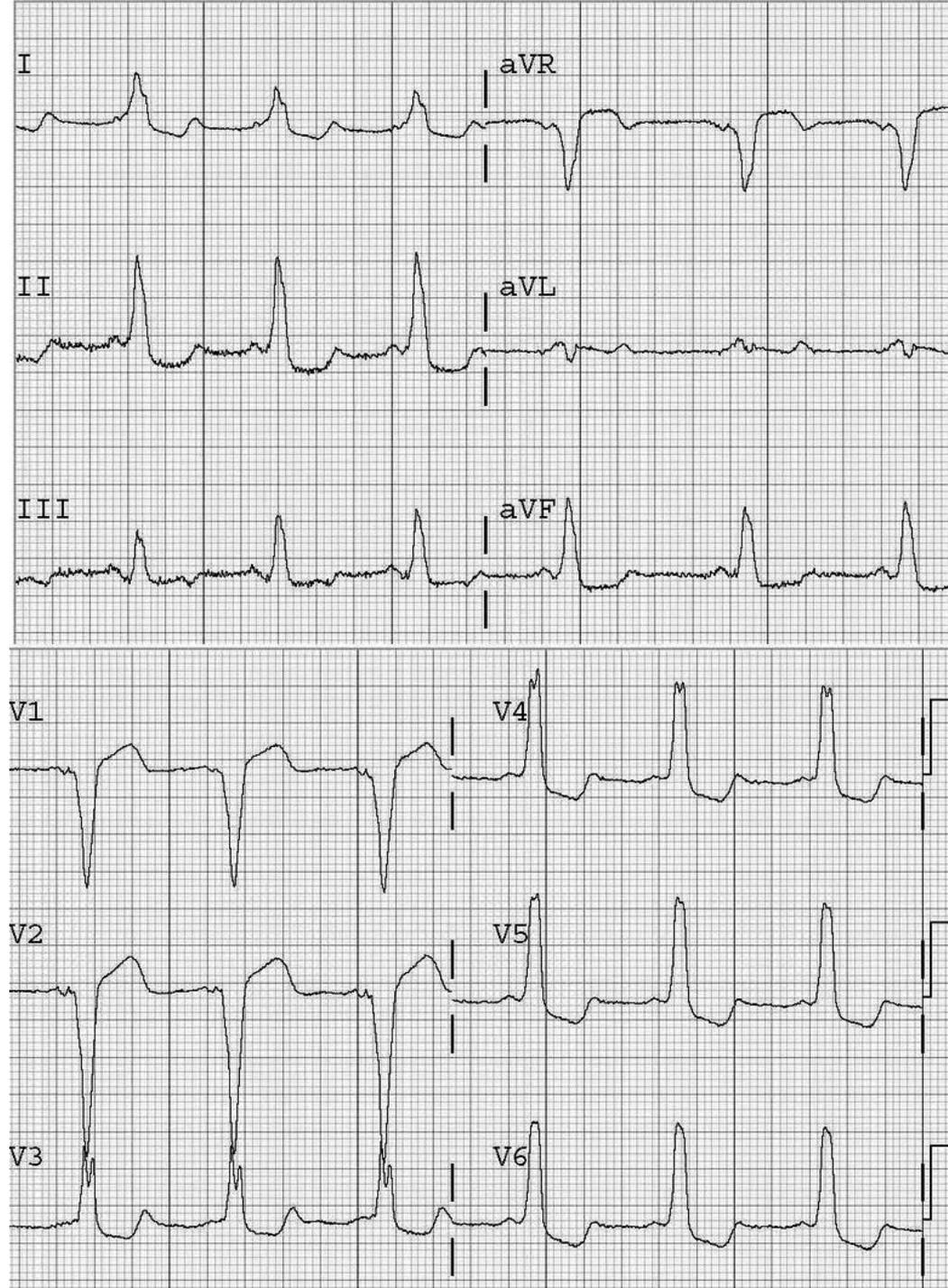
Klassisches VW-Aneurysma

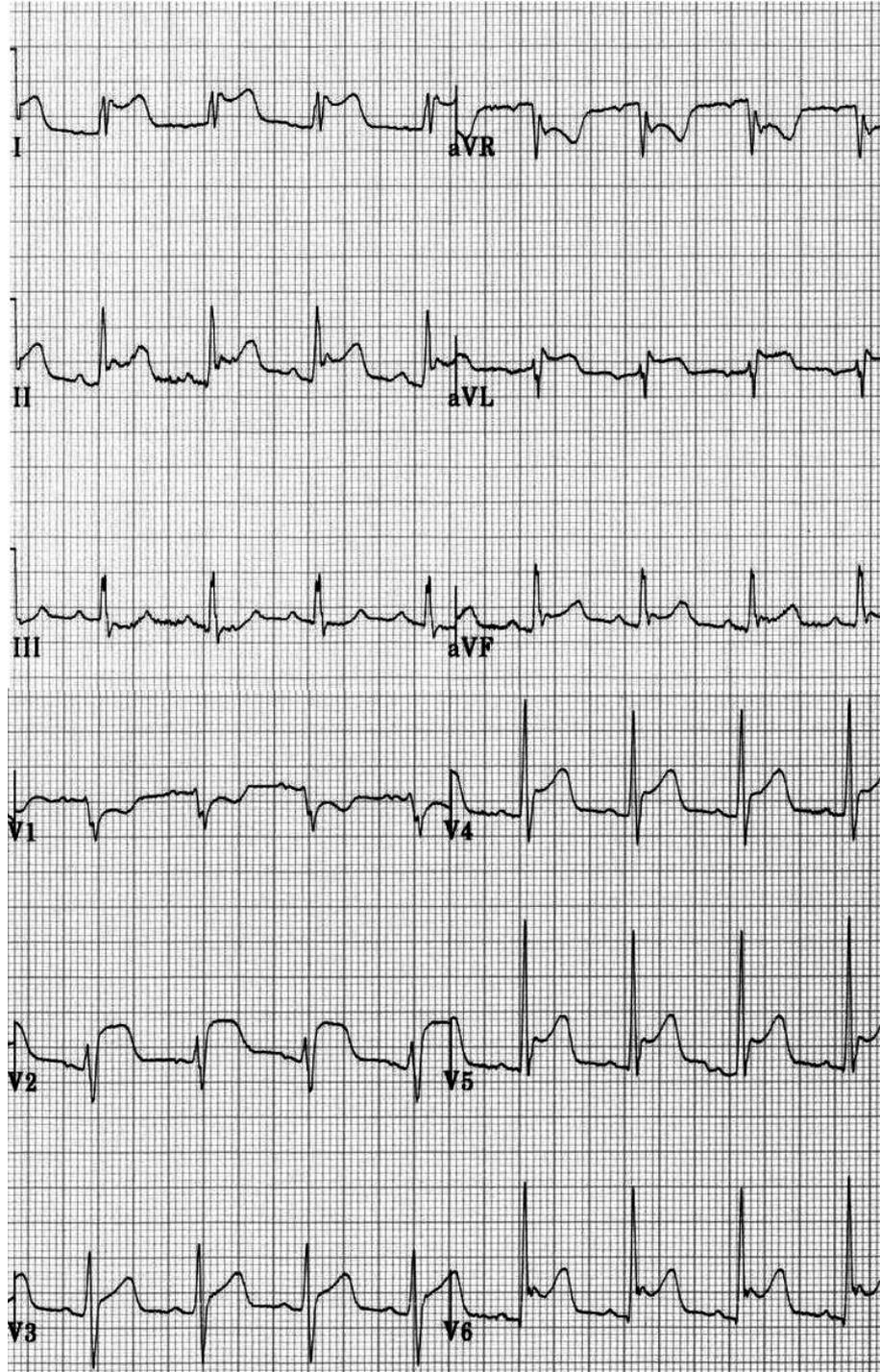




- Ventrikuläre Präzitation mit verkürzter PQ-Zeit

WPW-Syndrom Typ B





- Fast globale ST-Hebung (konkav bis auf V2)

Akute Perikarditis

