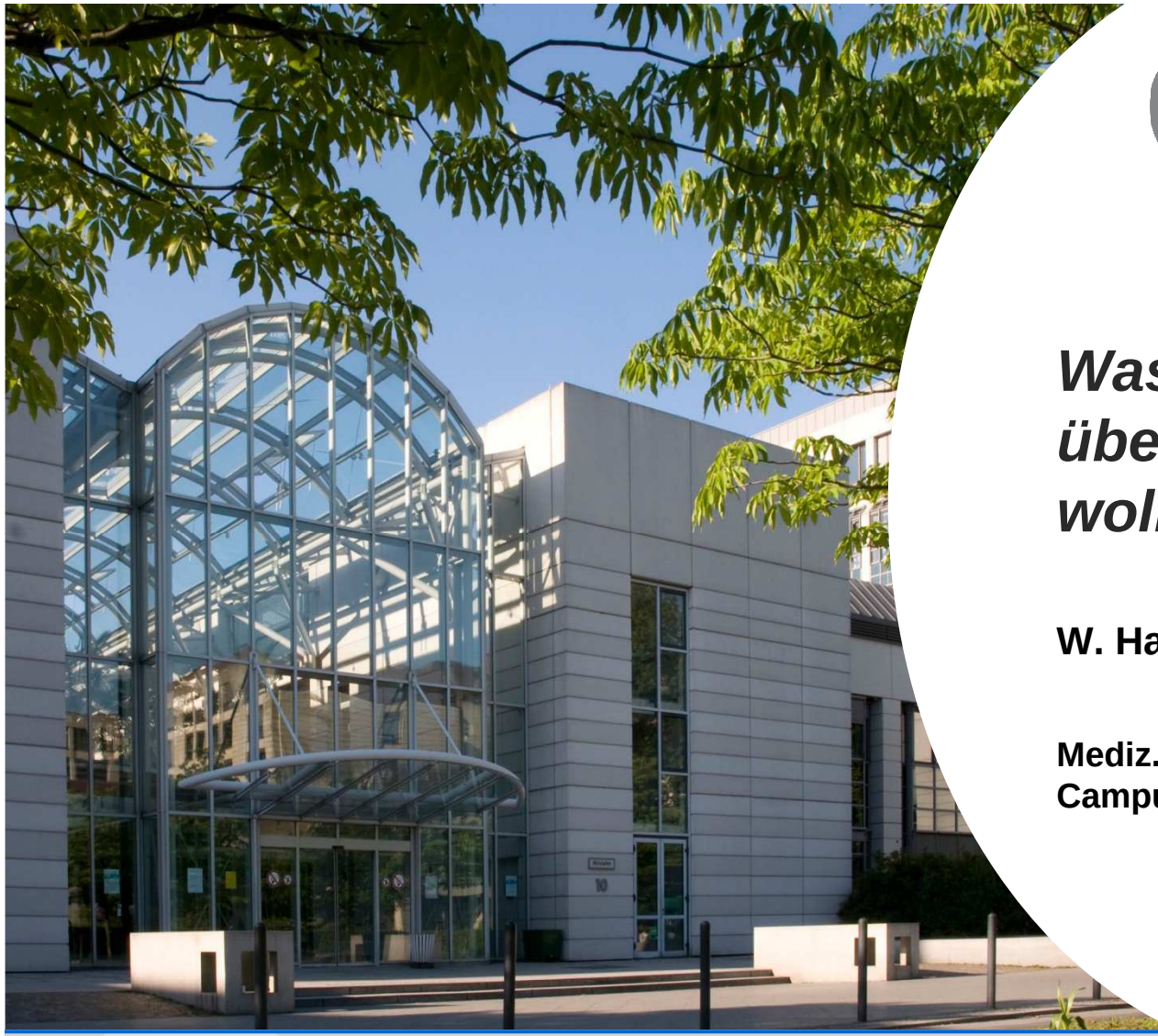

CHARITÉ
UNIVERSITÄTSMEDIZIN BERLIN

# *Was Sie schon immer über das EKG wissen wollten…*

**W. Haverkamp**

**Mediz. Klinik m. S. Kardiologie**
**Campus Virchow-Klinikum**

# Agenda

- Muster-Erkennung (Blickdiagnostik)
  - Linksventrikuläre Hypertrophie
  - Wegweisende Einzelbefunde

**Table 1. Criteria for Left Ventricular Hypertrophy**

| | Amplitude | First Author of Study | Year of Study Publication |
|---|---|---|---|
| Limb lead voltage | | | |
| (R I–S I)+(S III–R III) | >16 mm | Lewis[5] | 1914 |
| R I+S III | >25 mm | Gubner[6] | 1943 |
| R I | >15 mm | Gubner[6] | 1943 |
| R aVL | >11 mm | Sokolow[7] | 1949 |
| R aVF | >20 mm | Goldberger[65] | 1949 |
| Q or S aVR | >19 mm | Schack[73] | 1950 |
| R+S in any limb lead | >19 mm | Romhilt[9] | 1968 |
| Precordial lead voltage | | | |
| S $V_1$ | >23 mm | Wilson[76] | 1944 |
| S $V_2$ | >25 mm | Mazzoleni[69] | 1964 |
| S $V_1$+R $V_5$ | >35 mm | Sokolow[7] | 1949 |
| S $V_2$+R $V_{5,6}$ | >45 mm | Romhilt[72] | 1969 |
| S $V_{1-2}$+R $V_{5,6}$ | >35 mm | Murphy[64] | 1984 |
| S $V_{1,2}$+R $V_6$ | >40 mm | Grant[66] | 1957 |
| R+S any precordial lead | >35 mm | Grant[66] | 1957 |
| R $V_5$: R $V_6$ | >1.0 | Holt[67] | 1962 |
| R, any precordial lead | >26 mm | McPhie[70] | 1958 |
| S $V_2$+R $V_{4,5}$ | >45 mm | Wolff[77] | 1956 |
| R $V_5$ | >33 mm | Wilson[76] | 1944 |
| R $V_6$ | >25 mm | Wilson[76] | 1944 |
| Combinations of limb and precordial voltage | | | |
| RS aVF+$V_2$+$V_6$ (>30 years) | >59 mm | Manning[68] | 1964 |
| RS aVF+$V_2$+$V_6$ (<30 years) | >93 mm | Manning[68] | 1964 |
| S $V_3$+R aVL (men) | >28 mm | Casale[8] | 1985 |
| S $V_3$+R aVL (women) | >20 mm | Casale[8] | 1985 |
| Total 12-lead voltage | >175 mm | Siegel[74] | 1982 |
| Combinations of voltage and nonvoltage | | | |
| Voltage-STT-LAA-axis-QRS duration | Point score | Romhilt[9] | 1968 |
| (R aVL+S $V_3$)×QRS duration | >2436 mm/sec | Molloy[71] | 1992 |
| Total 12-lead voltage×QRS duration | >1742 mm/sec | Molloy[71] | 1992 |
| Criteria for use with left anterior fascicular block | | | |
| S $V_1$+R $V_5$+S $V_3$ | >25 | Bozzi[63] | 1976 |
| S $V_{1,2}$+R $V_6$+S $V_6$ | >25 | Bozzi[63] | 1976 |
| S III+max R/S any lead (men) | >30 | Gertsch[32] | 1988 |
| S III+max R/S any lead (women) | >28 | Gertsch[32] | 1988 |
| Criteria for use with right bundle-branch block | | | |
| Max R/S precordial lead (with LAD) | >29 mm | Vandenberg[75] | 1991 |
| S $V_1$ | >2 mm | Vandenberg[75] | 1991 |
| R $V_{5,6}$ | >15 mm | Vandenberg[75] | 1991 |
| S III+max R/S precordial (with LAD) | >40 mm | Vandenberg[75] | 1991 |
| R I | >11 mm | Vandenberg[75] | 1991 |

Amplitudes are given in millimeters, where 1 mm=0.1 mV. LAD indicates left axis deviation.

**AHA/ACCF/HRS Scientific Statement**

# AHA/ACCF/HRS Recommendations for the Standardization and Interpretation of the Electrocardiogram

## Part V: Electrocardiogram Changes Associated With Cardiac Chamber Hypertrophy

**A Scientific Statement From the American Heart Association Electrocardiography and Arrhythmias Committee, Council on Clinical Cardiology; the American College of Cardiology Foundation; and the Heart Rhythm Society**

*Endorsed by the International Society for Computerized Electrocardiology*

E. William Hancock, MD, FACC; Barbara J. Deal, MD, FACC; David M. Mirvis, MD; Peter Okin, MD, FACC; Paul Kligfield, MD, FAHA, FACC; Leonard S. Gettes, MD, FAHA, FACC

Hancock et al. 2009

# LVH im EKG: Amplitudenkriterien

| | | | |
|---|---|---|---|
| Precordial lead voltage | | | |
| S $V_1$ | >23 mm | Wilson[76] | 1944 |
| S $V_2$ | >25 mm | Mazzoleni[69] | 1964 |
| S $V_1$+R $V_5$ | >35 mm | Sokolow[7] | 1949 |
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Hancock et al. 2009

VOL. 37 FEBRUARY, 1949 NO. 2

# Original Communications

## THE VENTRICULAR COMPLEX IN LEFT VENTRICULAR HYPERTROPHY AS OBTAINED BY UNIPOLAR PRECORDIAL AND LIMB LEADS

MAURICE SOKOLOW, M.D., AND THOMAS P. LYON, M.D.

One hundred forty-seven patients remained of whom 90 per cent had hypertension exceeding 155/95, with a mean blood pressure of 197/117, and a mean increase in the transverse diameter of the heart[20] of 15.8 per cent. Electrocardiographic studies of the patients in this group were made as will be described in detail later. As controls, 151 normal subjects, whose histories, physical examinations, electrocardiograms, and roentgenograms of the chest gave negative results, were studied similarly. This control group consisted of healthy nurses, medical students, members of the house staff, and flying personnel of a commercial airline. The mean age of the normal subjects was 35.1 years.

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## THE VENTRICULAR COMPLEX IN LEFT VENTRICULAR HYPERTROPHY AS OBTAINED BY UNIPOLAR PRECORDIAL AND LIMB LEADS

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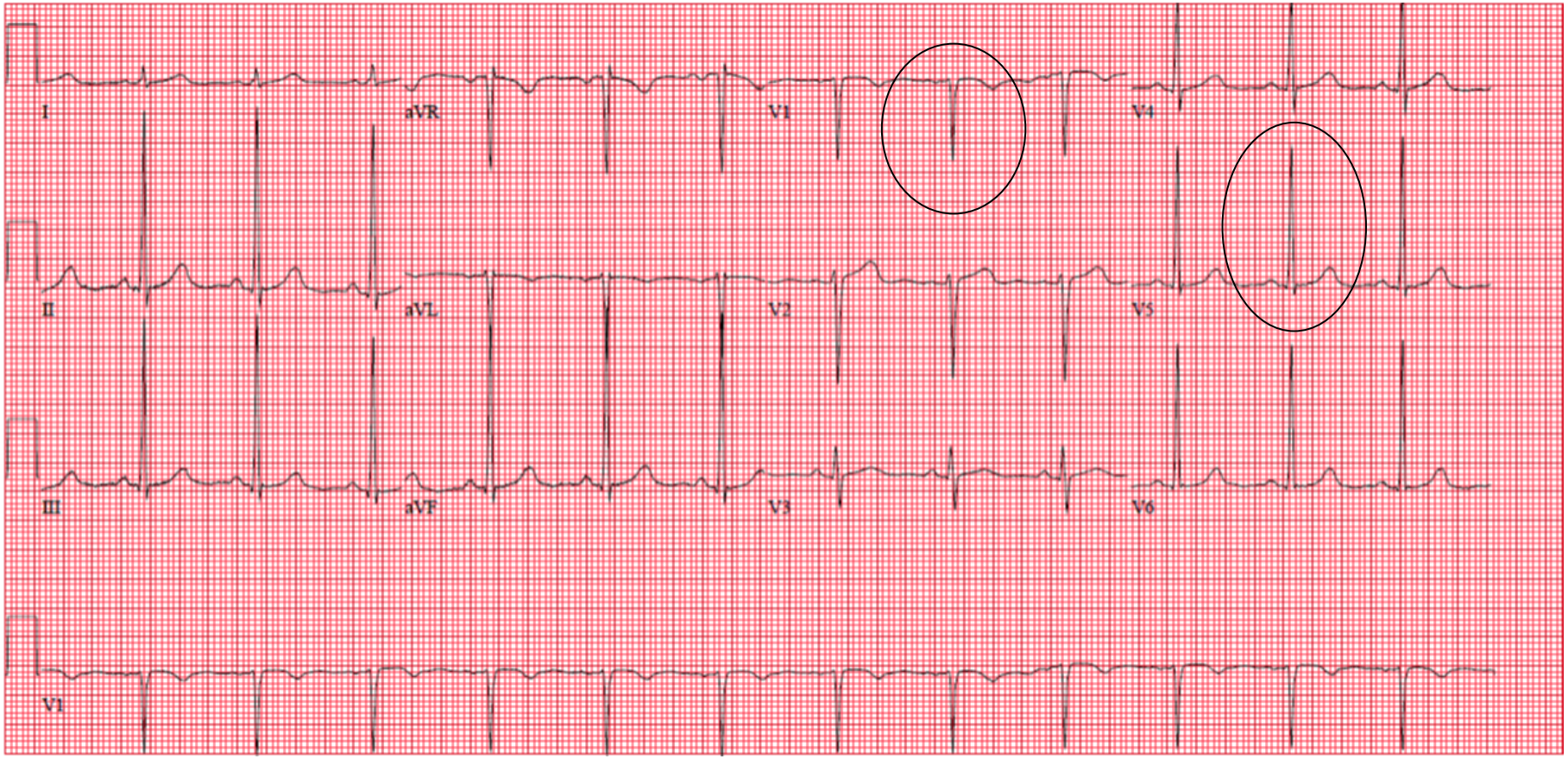
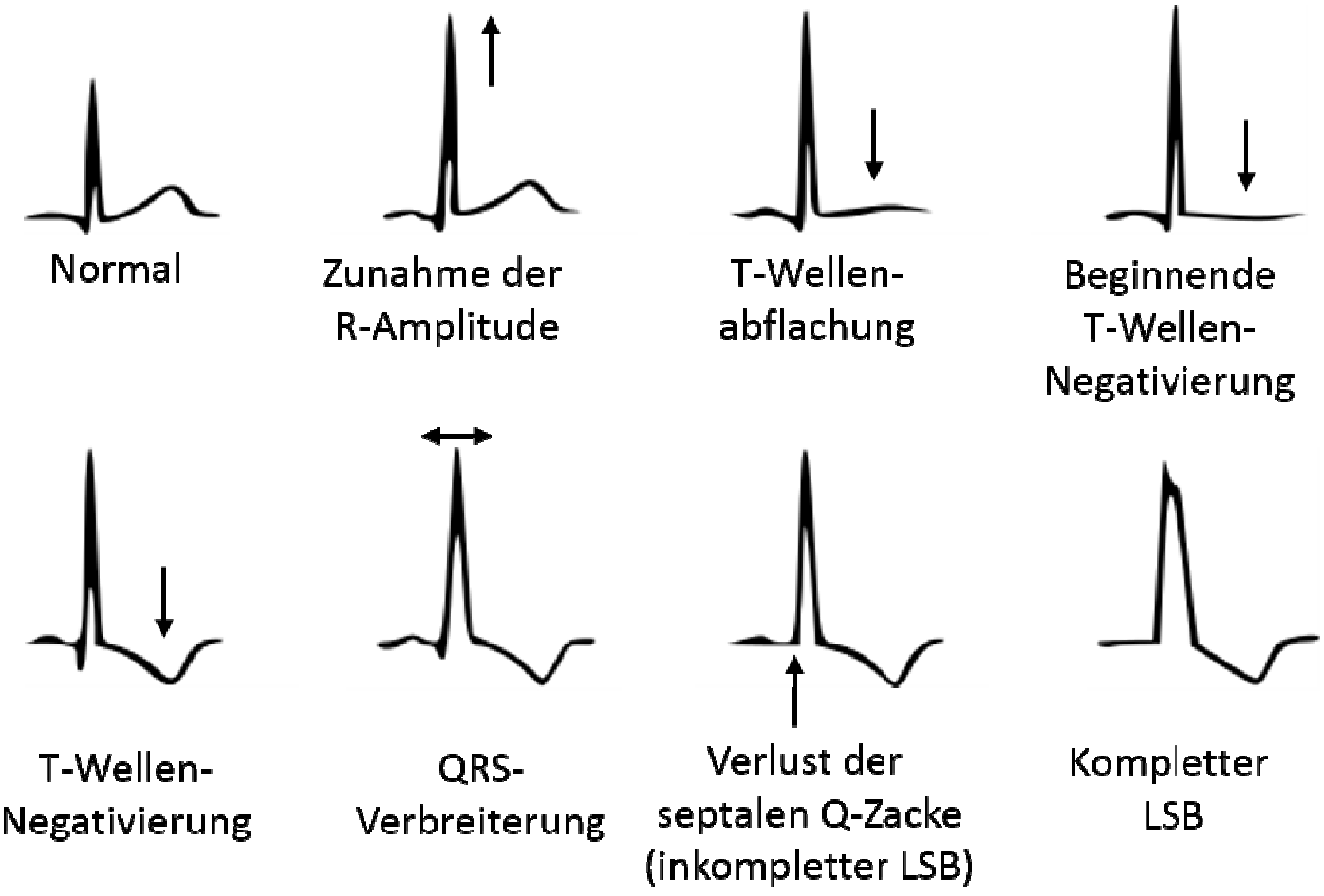
7. The diagnostic significance of the voltage of the left ventricular potentials as reflected by the sum of the R wave in $V_5$ or $V_6$ and the S wave in $V_1$ is emphasized. Thirty-two per cent of patients with left ventricular hypertrophy had the sum of these two potentials exceed 35 mm., whereas in no normal person did this sum exceed 35 mm.; in 96 per cent of normal individuals the sum was found to be below 30 millimeters.

# EKG: Sokolow-Index 4,0 mV – falsch positiver Befund



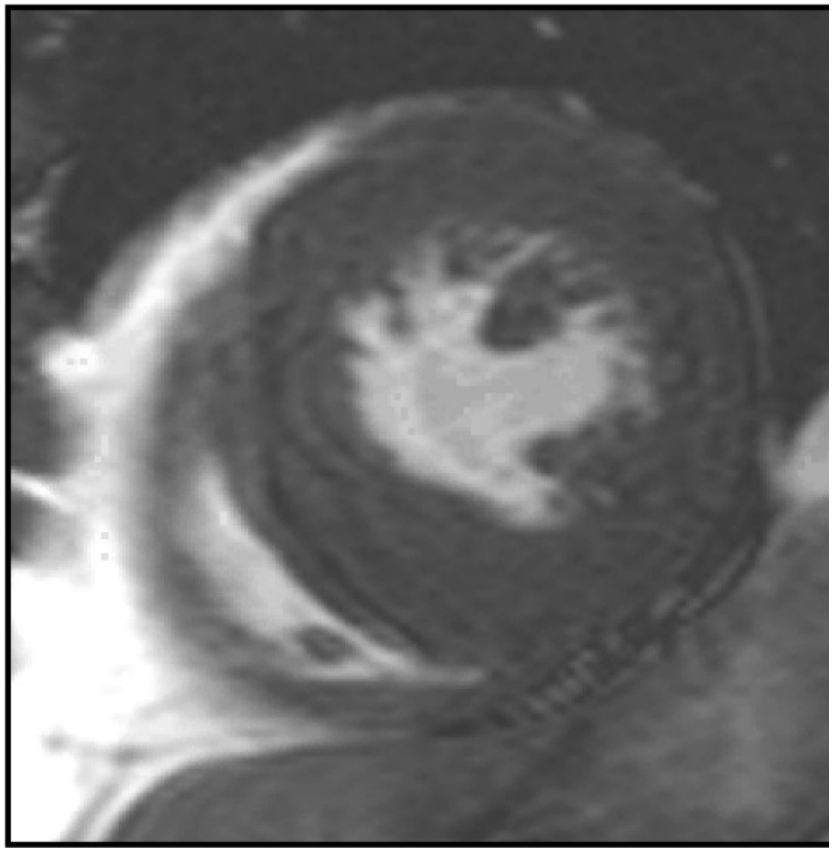

39-jähriger Patient mit asthenischem Körperbau.

# EKG: Linksventrikuläre Hypertrophie

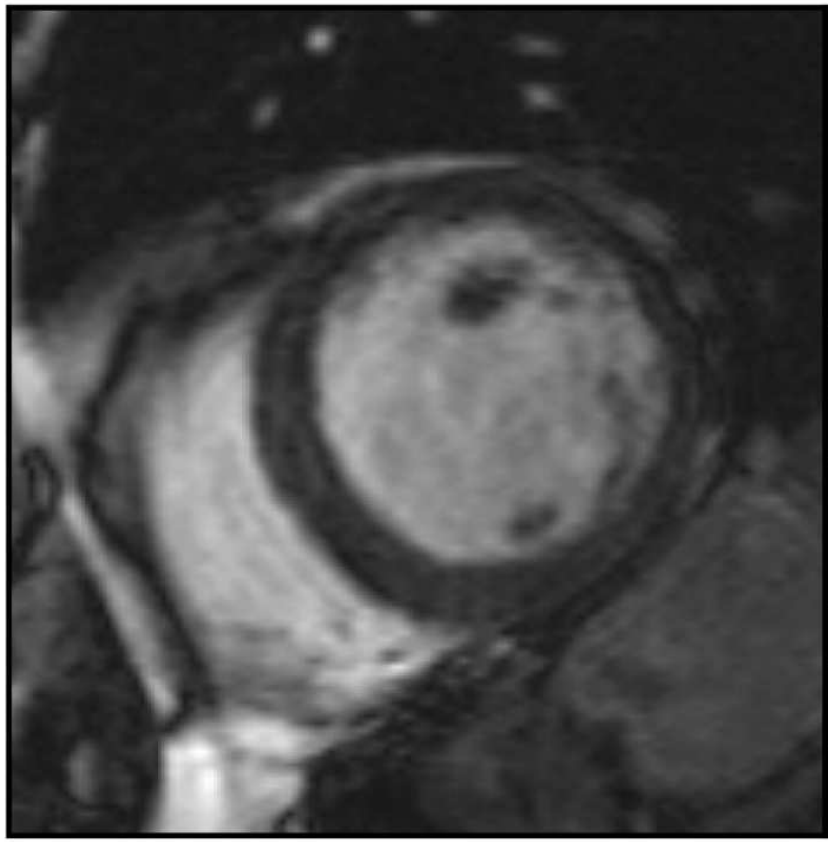


# MRT: konzentrische und exzentrische LV-Hypertrophie

**Konzentrische LVH**



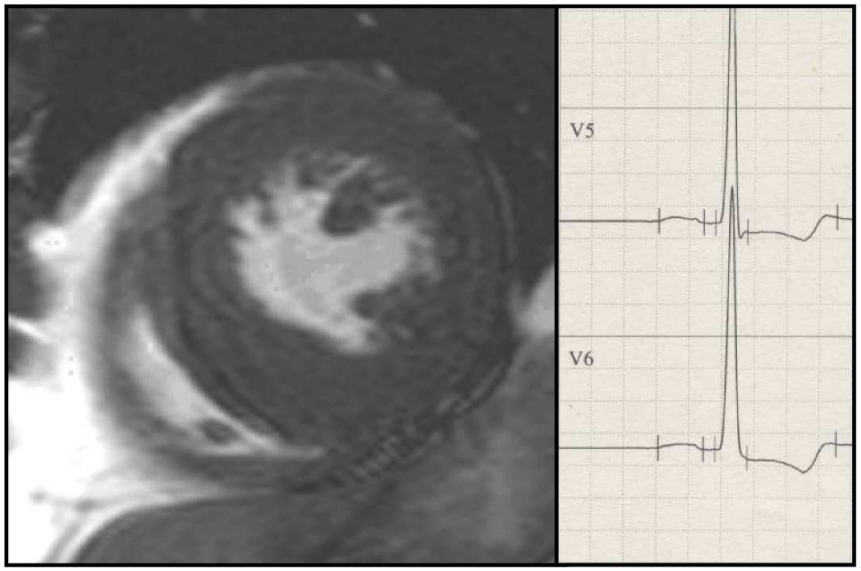
**Exzentrische LVH**



Buchner et al. 2009

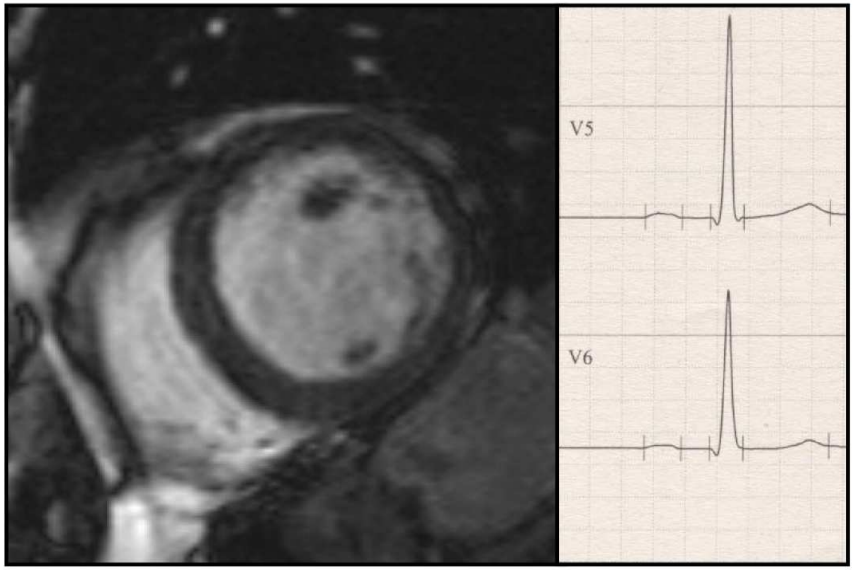
# MRT: konzentrische und exzentrische LV-Hypertrophie

**Konzentrische LVH**




Konzentrische LVH: Erhöhtes M/V und erhöhter LVMI

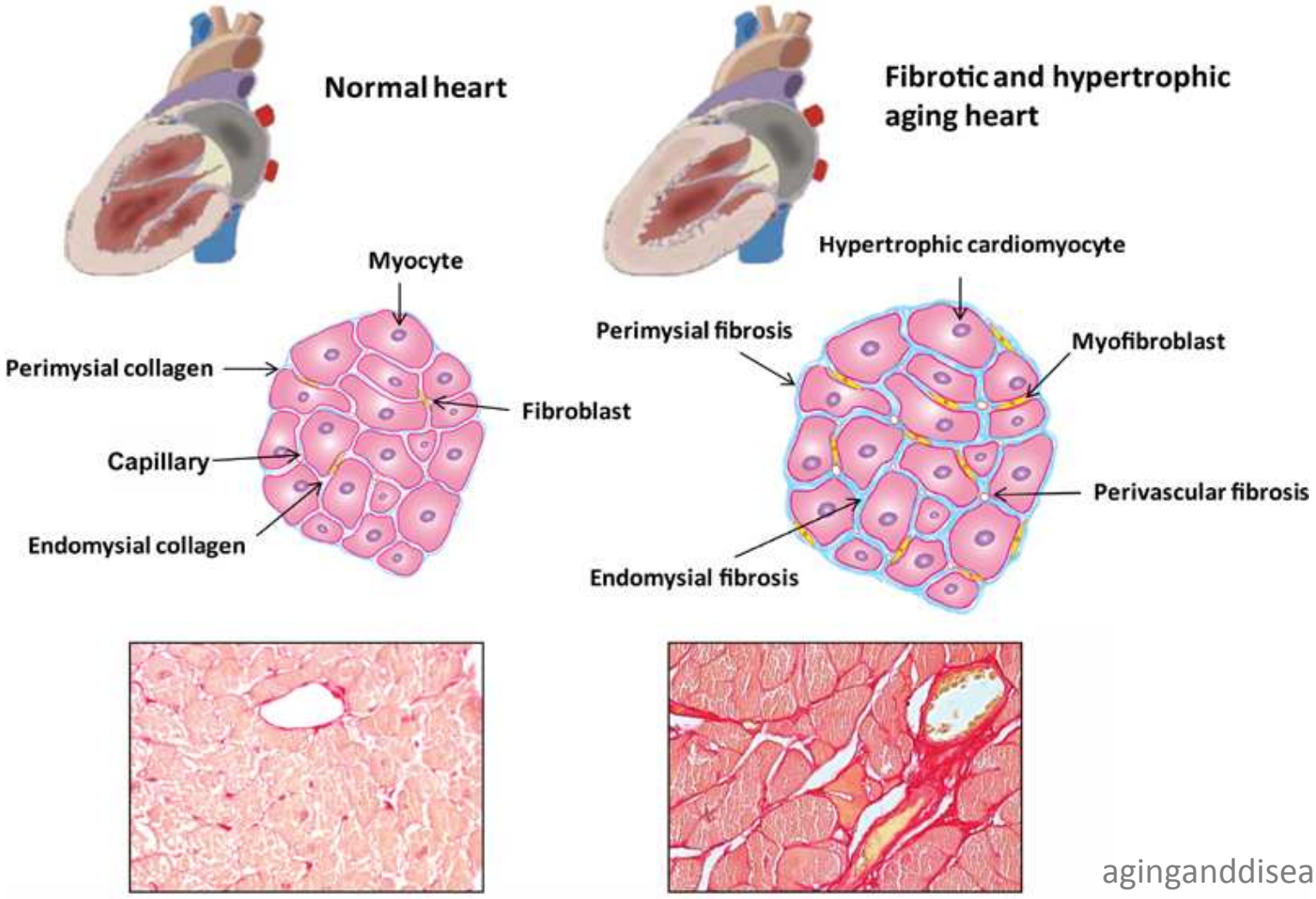
**Exzentrische LVH**




Exzentrische LVH: Normales M/V und erhöhter LVMI

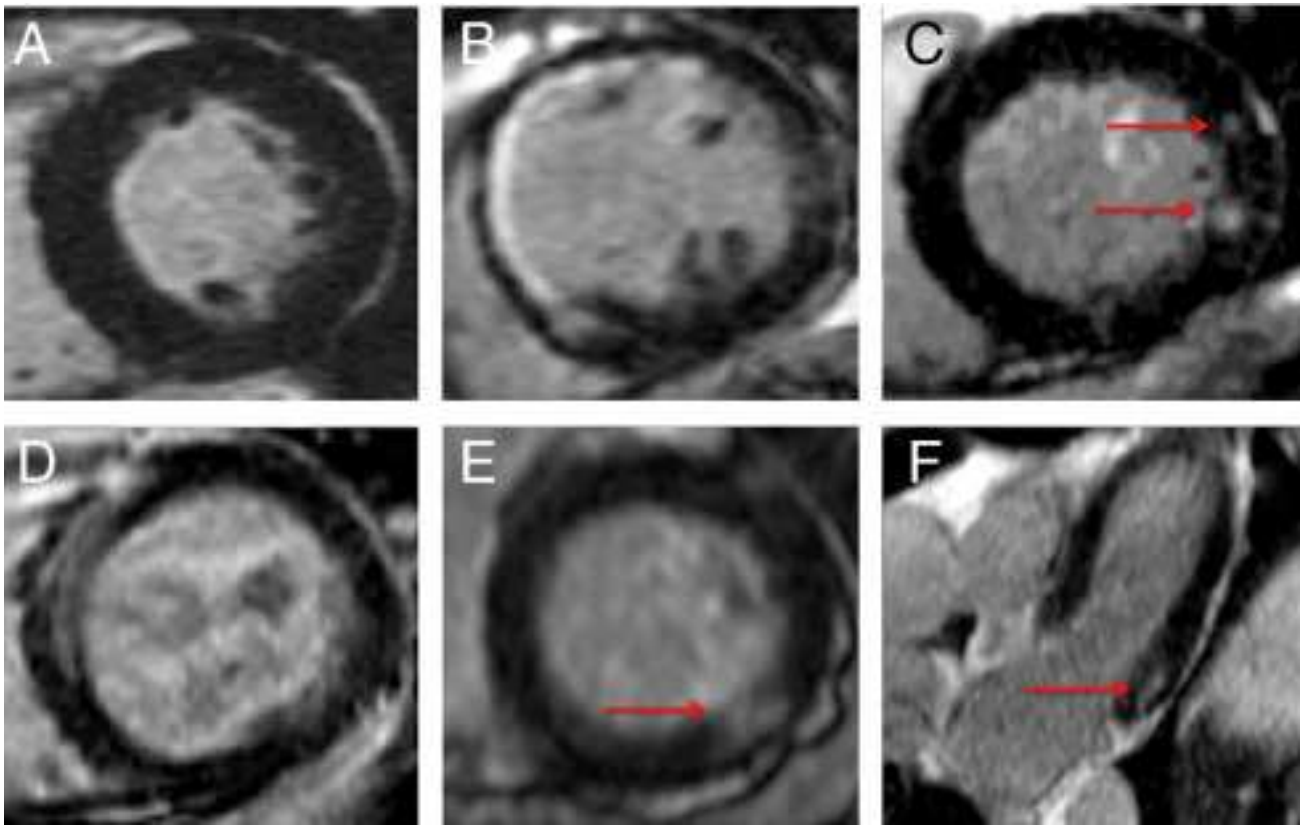
Buchner et al. 2009

# Myokardiale Hypertrophie und Fibrose




aginganddisease.org

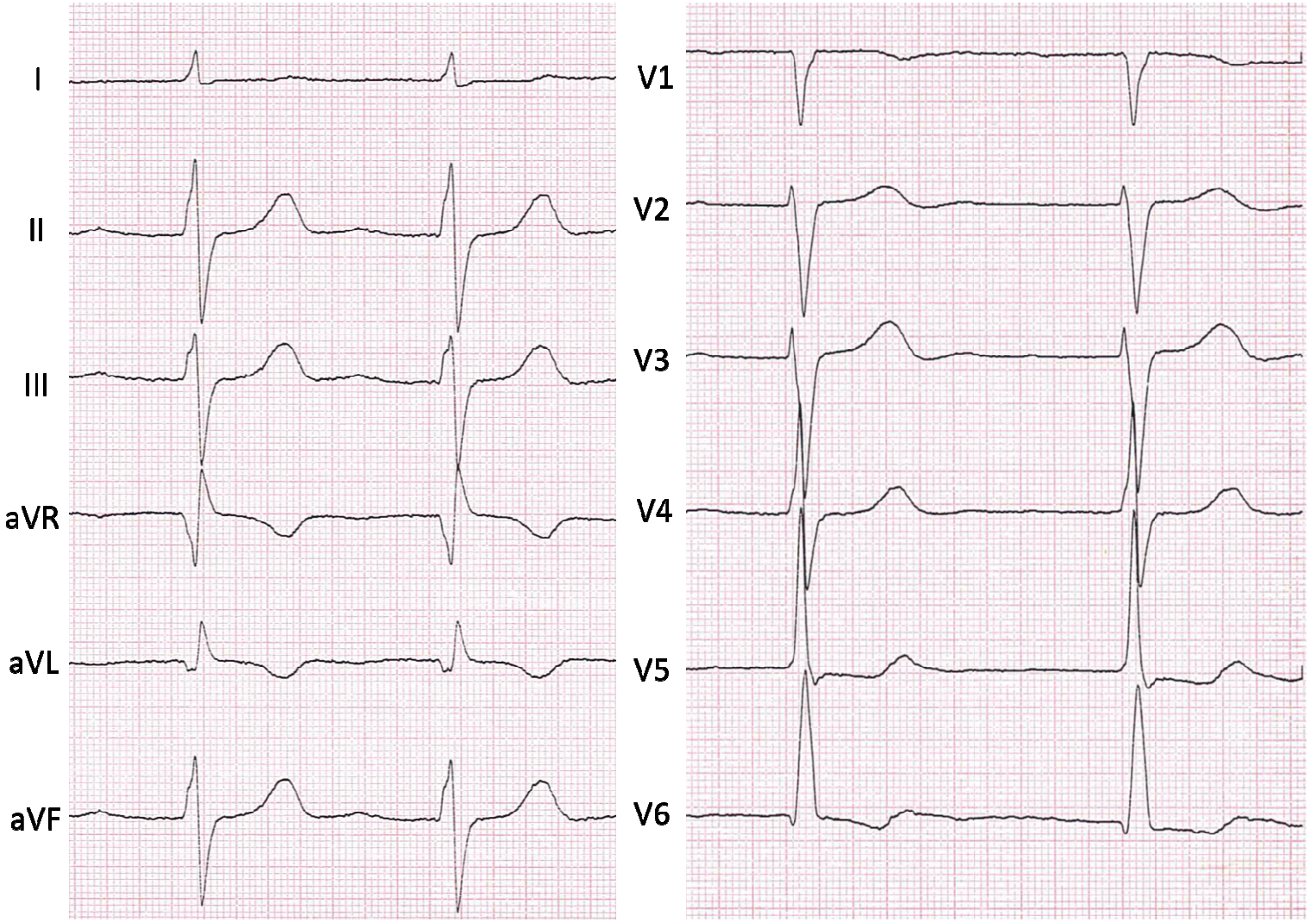
# MRT: Fibrose (LGE) bei Aortenstenose




→ Late-Gadolinium-Enhancement

Dweck et al. 2011

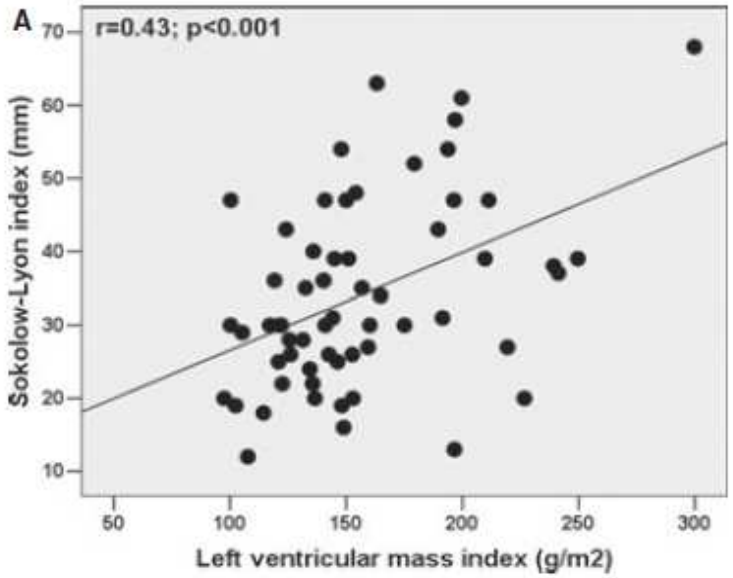
# EKG: Linksschädigung (left ventricular strain)



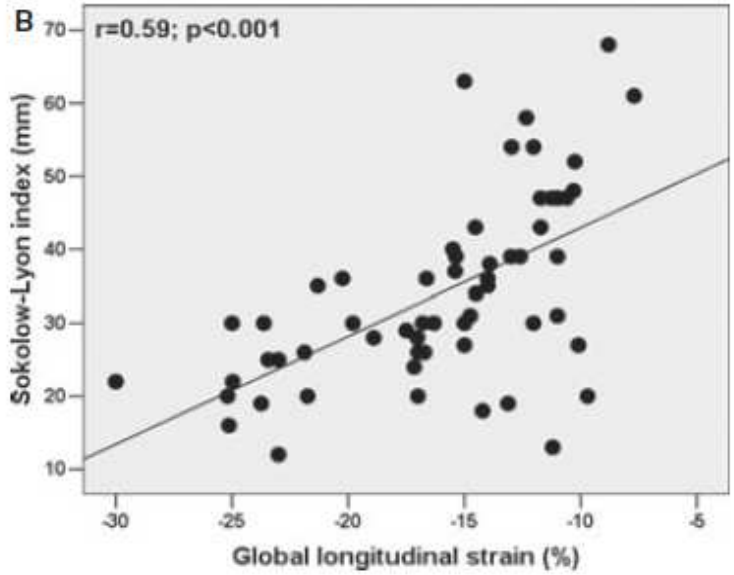

www.fokus-ekg.de

# EKG: Solow-Lyon-Index vs. LVM und

LVM (Echo)




Globale Strain-Rate (Echo)



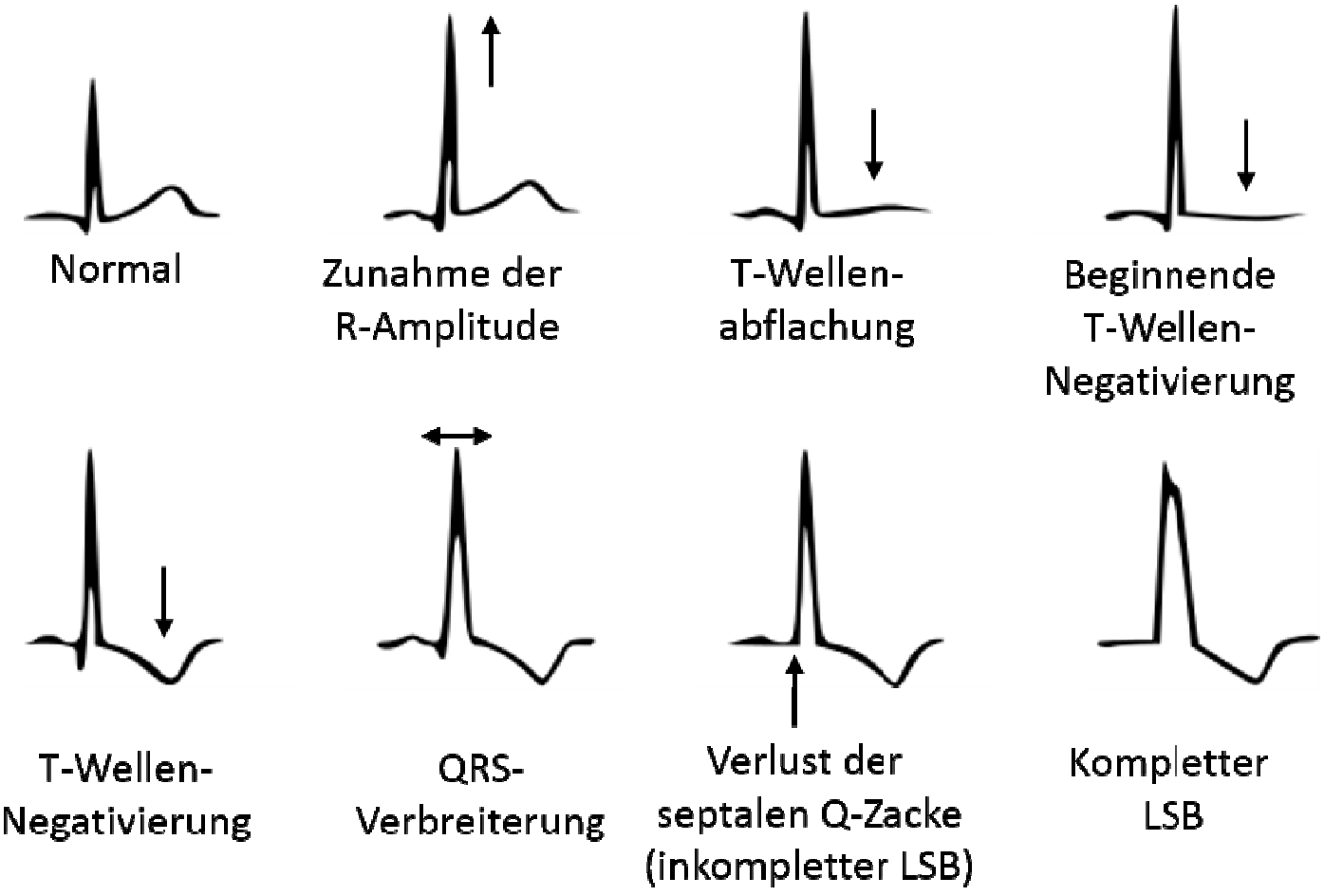

- Hypertrophiezeichen stellen nicht nur ein Surrogat-Parameter für die linksventrikuläre Masse dar, sondern korrelieren auch mit dem Ausmaß des linksventrikulären Remodelings (Struktur und Funktion)

Beladan et al. 2013

# LVH-Hypertrophie im EKG und Patientenmanagement

- LVH-Parameter (Amplitudenkriterien, QRS-Kriterien, abnorme Repolarisation) sind insbesondere bei der **Verlaufs-beobachtung** wichtig:
  - Bei therapierrefraktärer Hypertonie sind sie mit einer erhöhten kardiovaskulären Morbidität und Mortalität assoziiert.
  - Eine Abnahme der LVH im EKG bei arterieller Hypertonie ist mit einer günstigeren Prognose verbunden – ein Persistieren mit einer ungünstigeren Prognose.

# Linksventrikuläre Hypertrophie-Muster im EKG



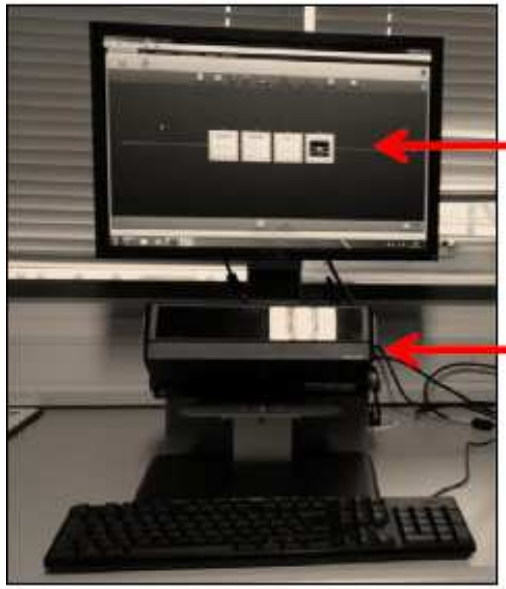
# Sherlock Holmes

***Watson …***

– *You know my methods, Watson!*

– *You did not know where to look, and so you missed all that was important.*

# EKG-Analyse: Eye-Tracking

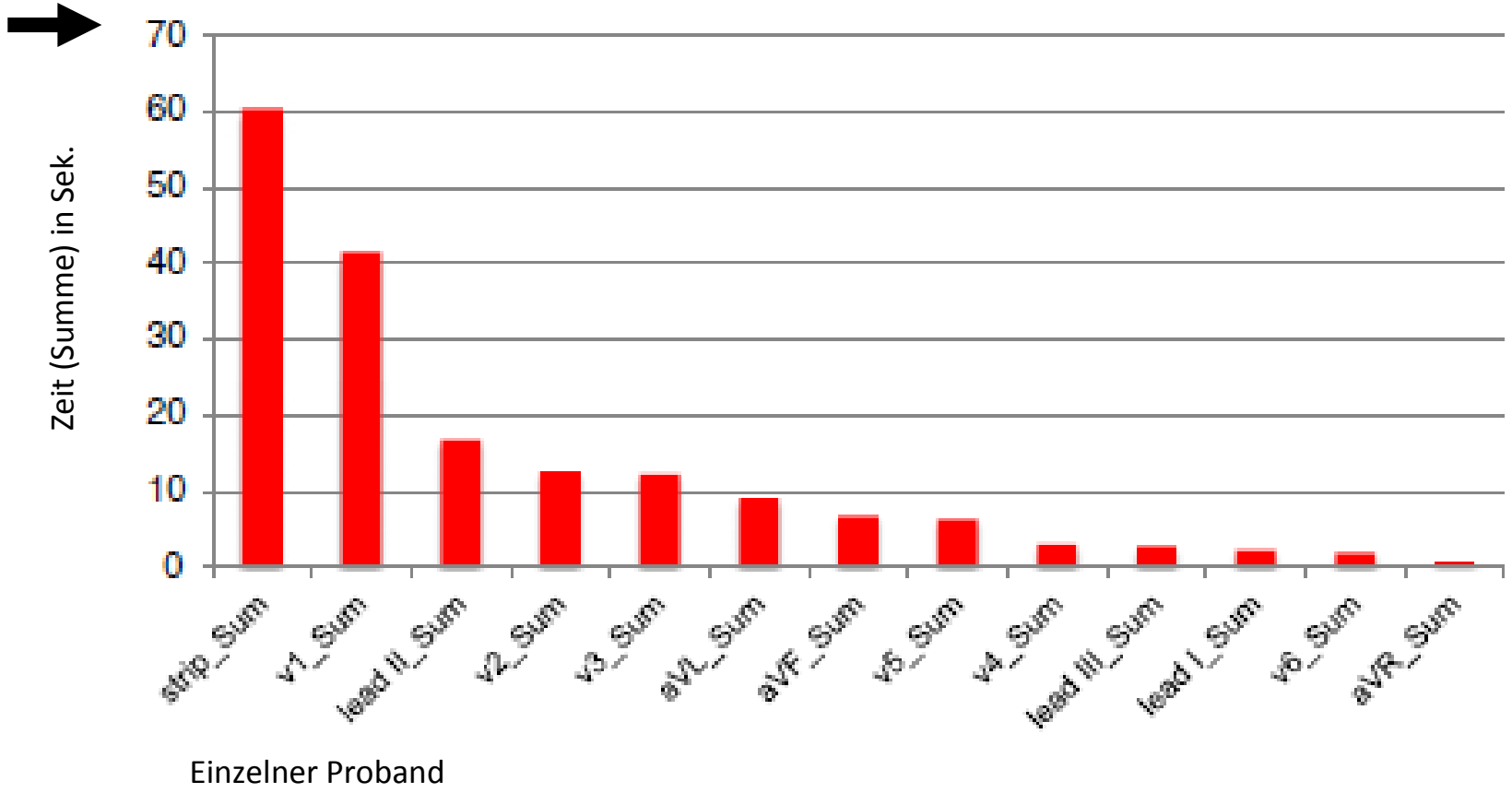


High resolution (1440px x 900px) 24" LCD monitor

Tobii Eye Tracker System

Breen et al. 2014

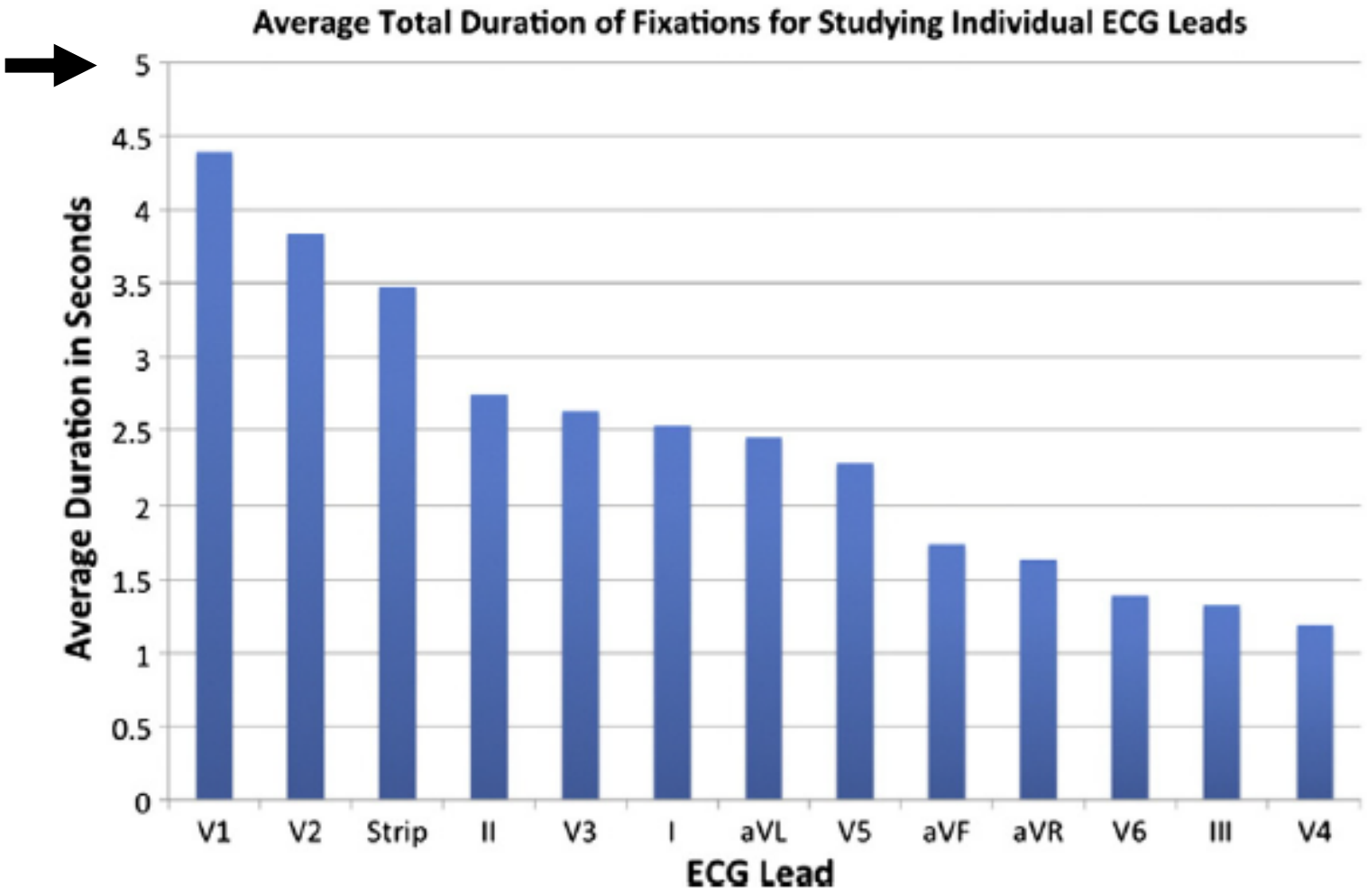
# EKG und Eye-Tracking: EKG-Anfänger




Einzelner Proband

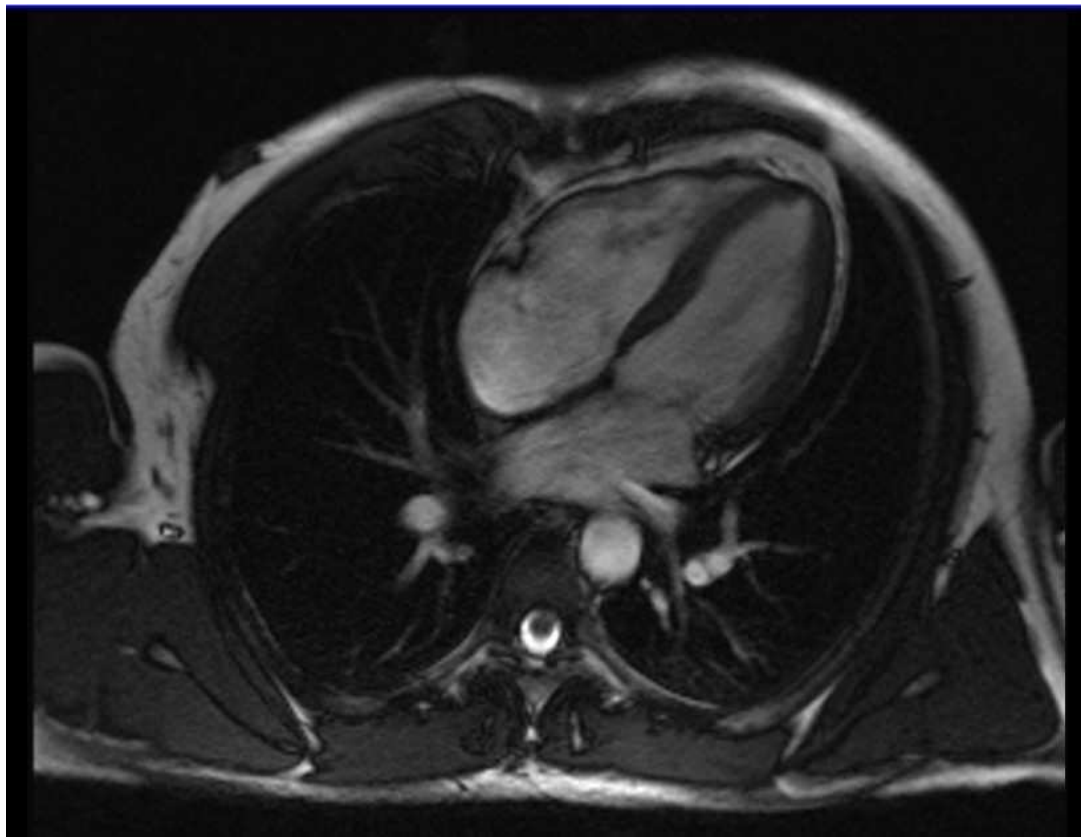
Breen et al. 2014

# EKG und Eye-Tracking: Experten

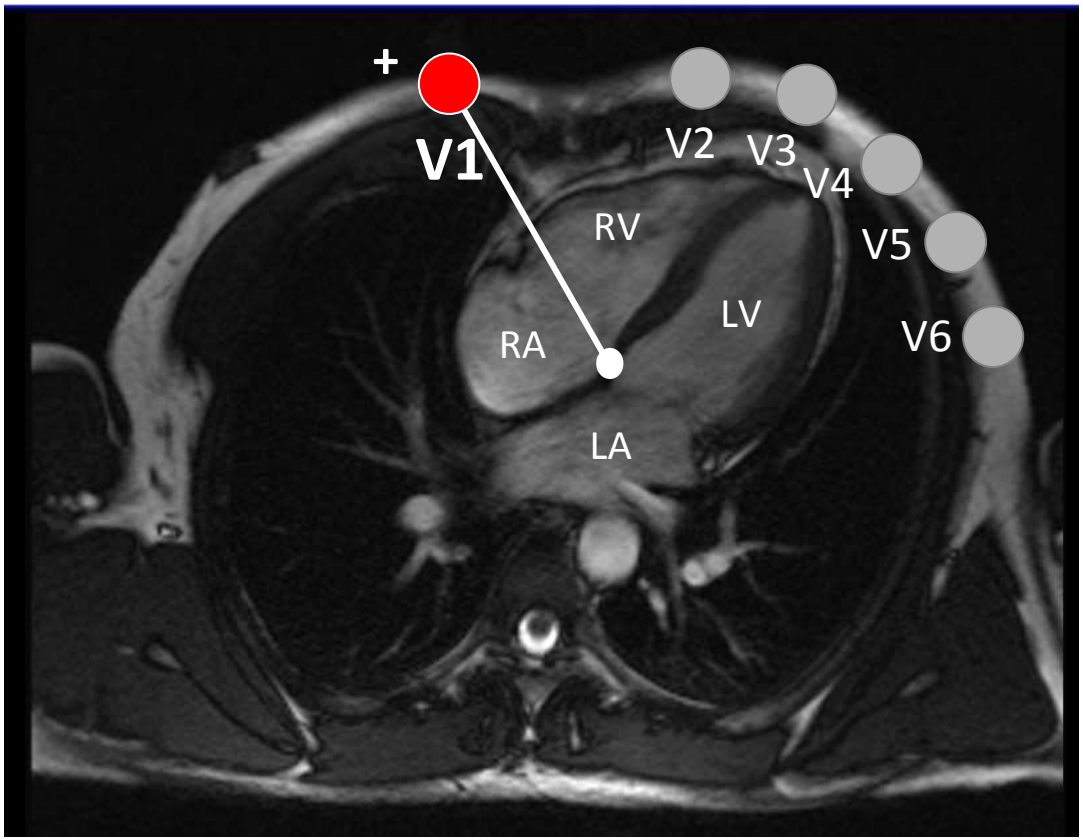



Bond et al. 2014

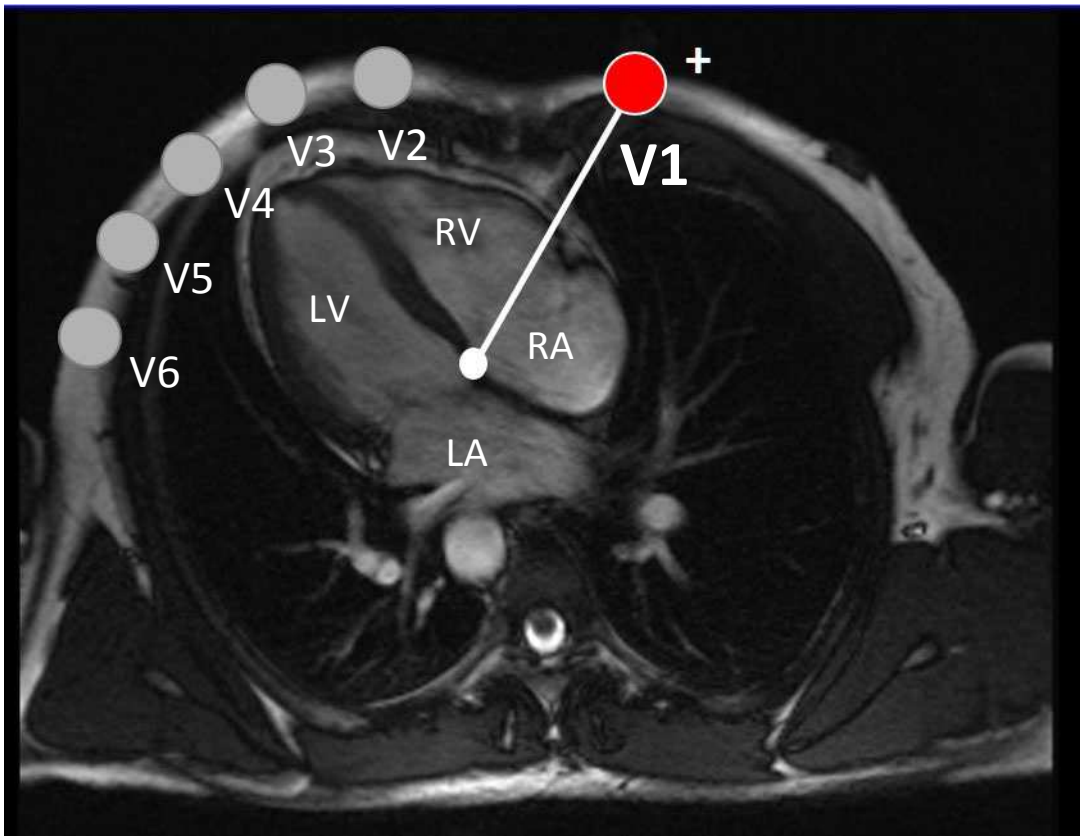
# Ableitung V1 - MRT



# Ableitung V1 - MRT

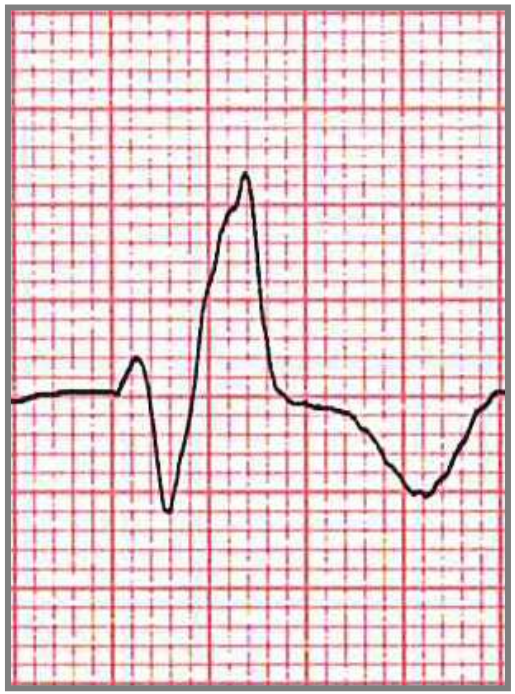


# Ableitung V1 – MRT horizontal gespiegelt



# Ableitung V1: Verdachtsdiagnose?

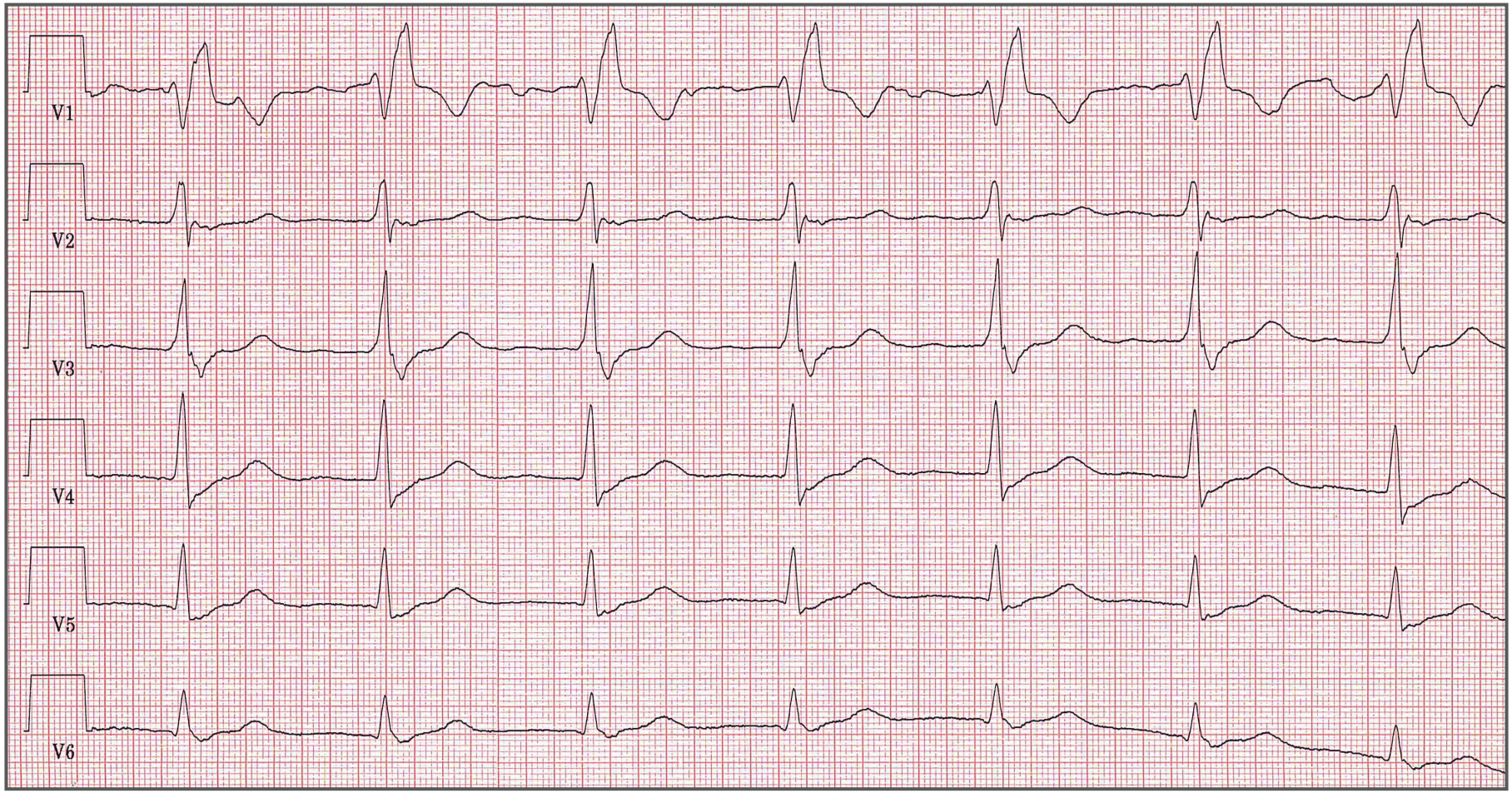
**V1**



50 mm/s

1 mm = 20 ms

# Ableitung V1: Rechtsschenkelblock

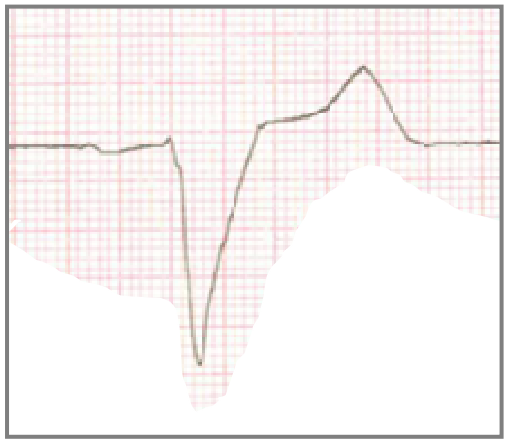


# RSB: EKG-Kriterien

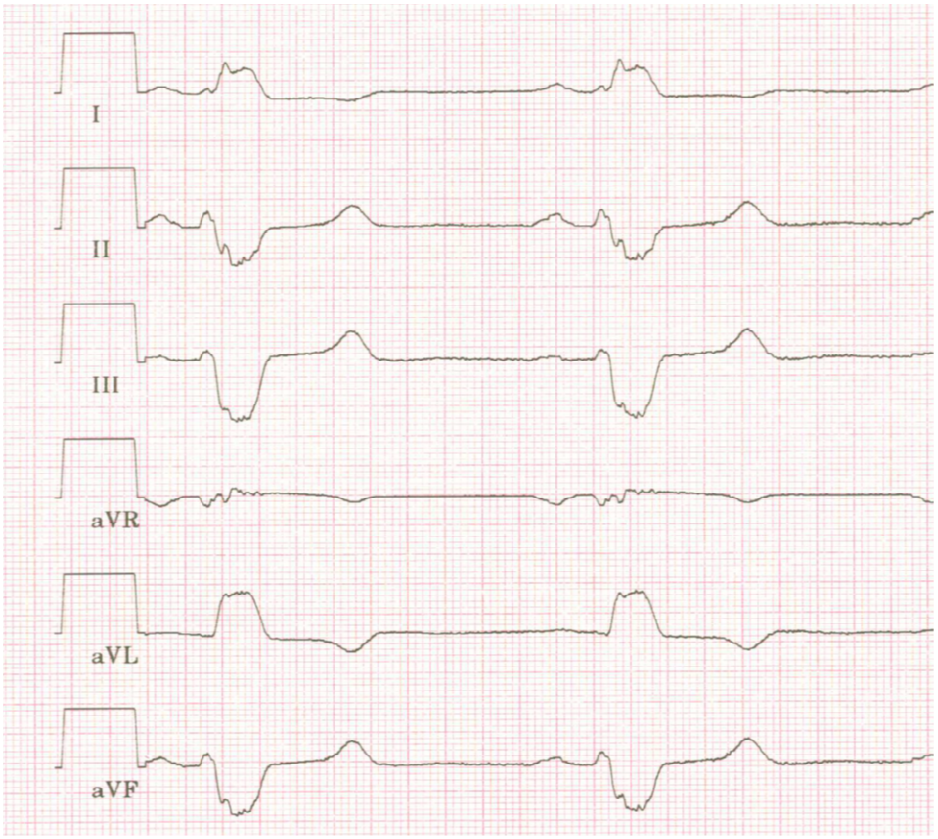
- QRS-Dauer ≥ 120 ms (definiert die Schenkelblockierung)
- rSR´-Komplex in V1, so genannte M-Form (verspätete rechtsventrikuläre Aktivierung)
- Verspätung der endgültigen größten Negativitätsbewegung in V1 (> 50 ms)
- Breite S-Zacken in I, aVL und V5/6 (Spiegelbild der verspäteten rechtsventrikulären Aktivierung)

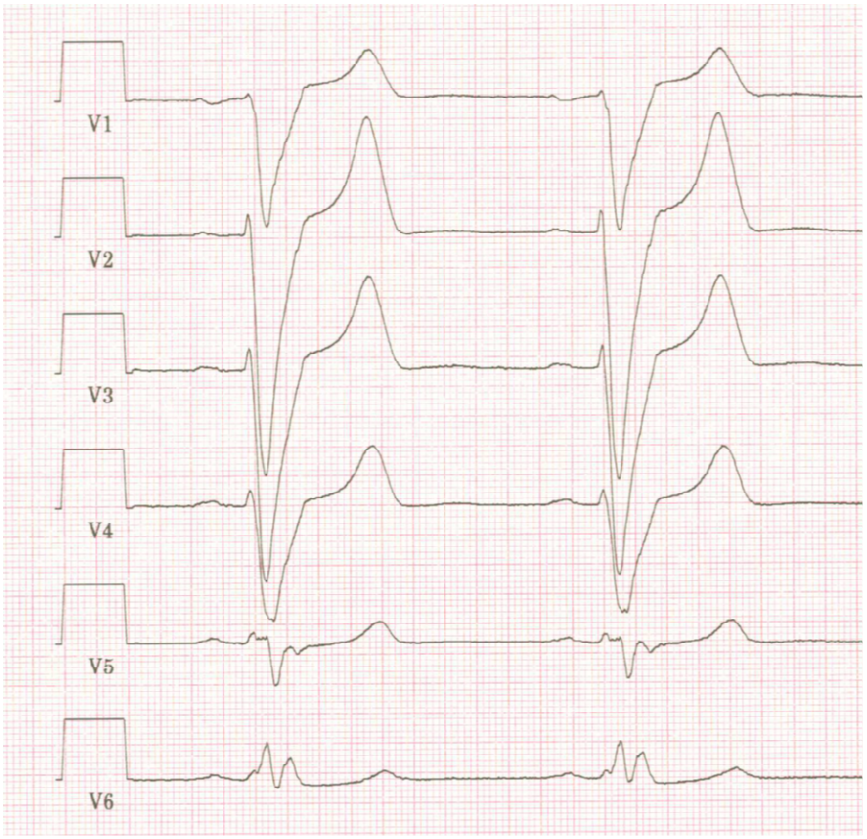
# Ableitung V1: Verdachtsdiagnose?

**V1**



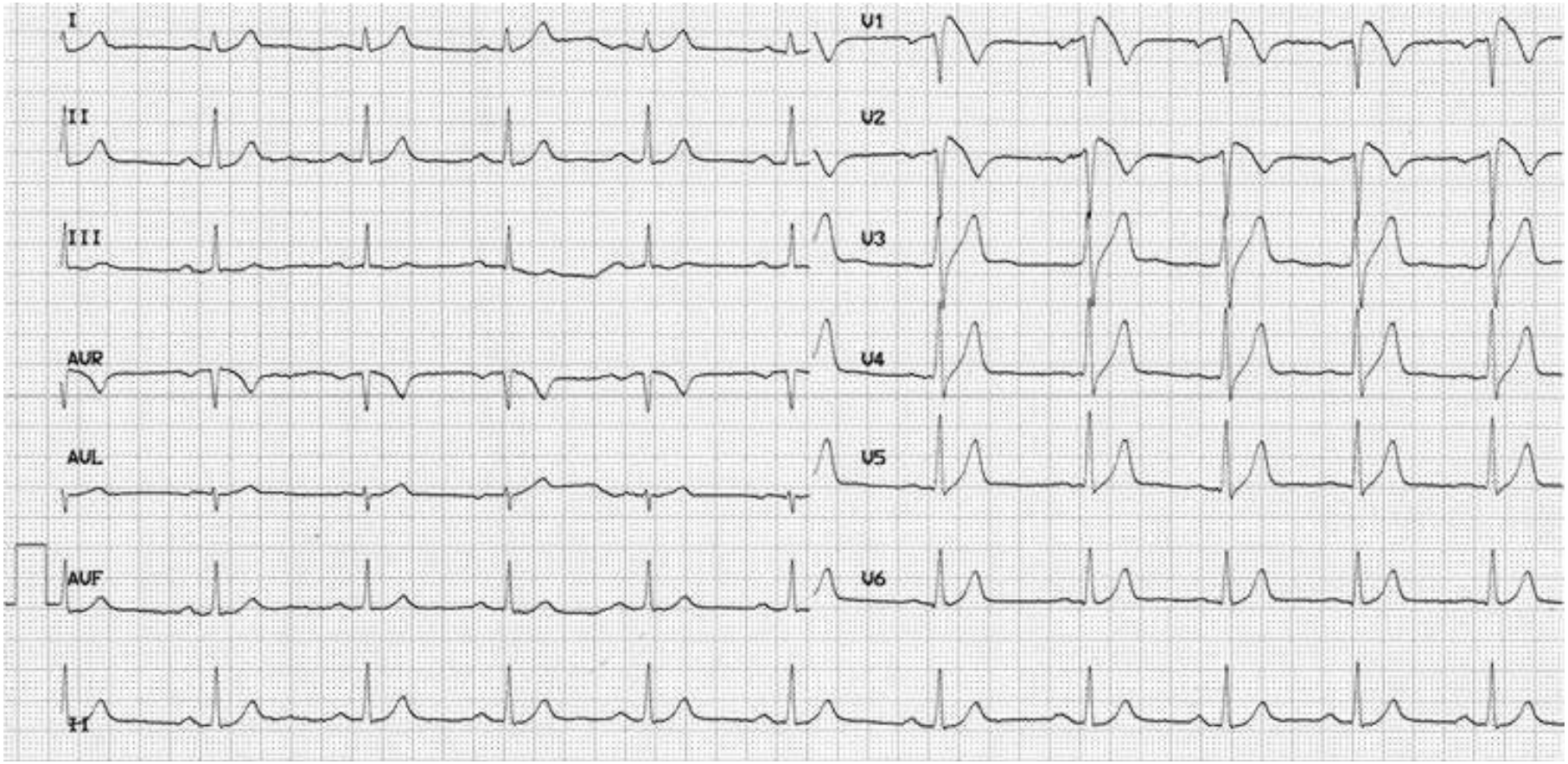
# Ableitung V1: kompletter Linksschenkelblock



# Ableitung V1: Verdachtsdiagnose?

# Brugada-Syndrom

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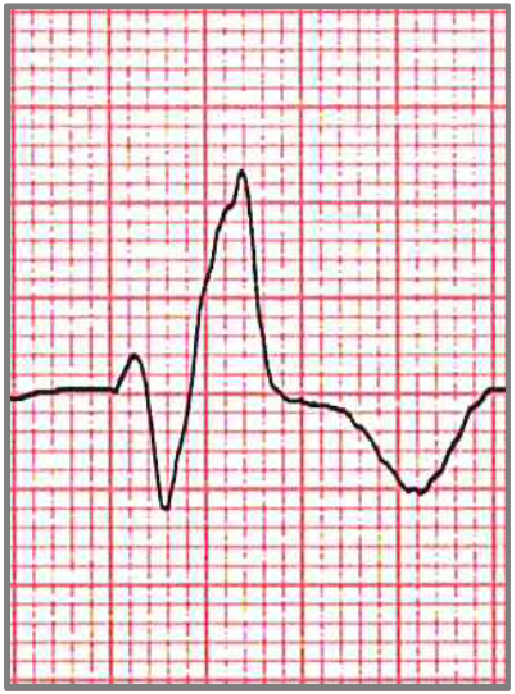
# Brugada vs. RSB

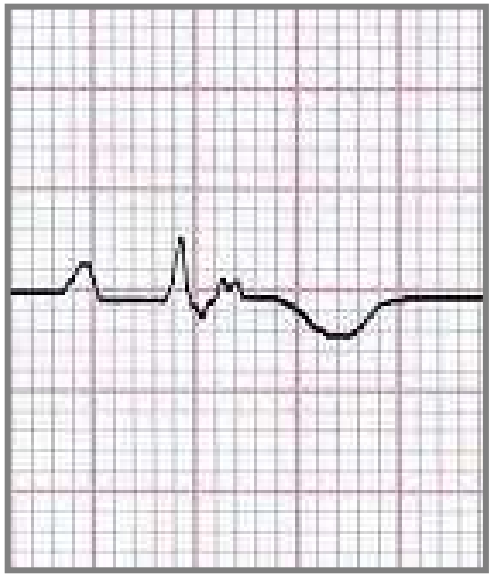
**Brugada-EKG Typ 1**

**RSB**



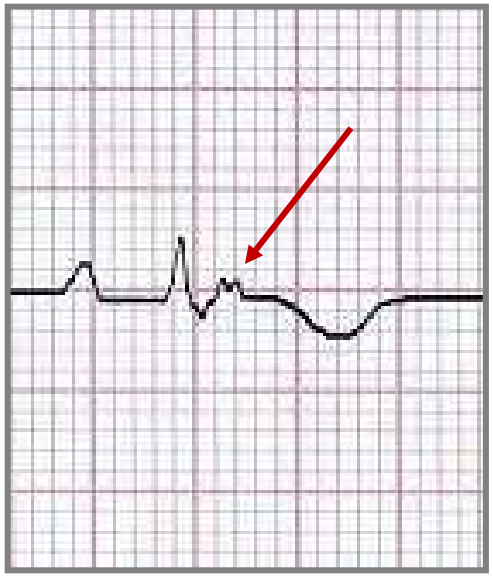
# Ableitung V1: Verdachtsdiagnose?

**V1**

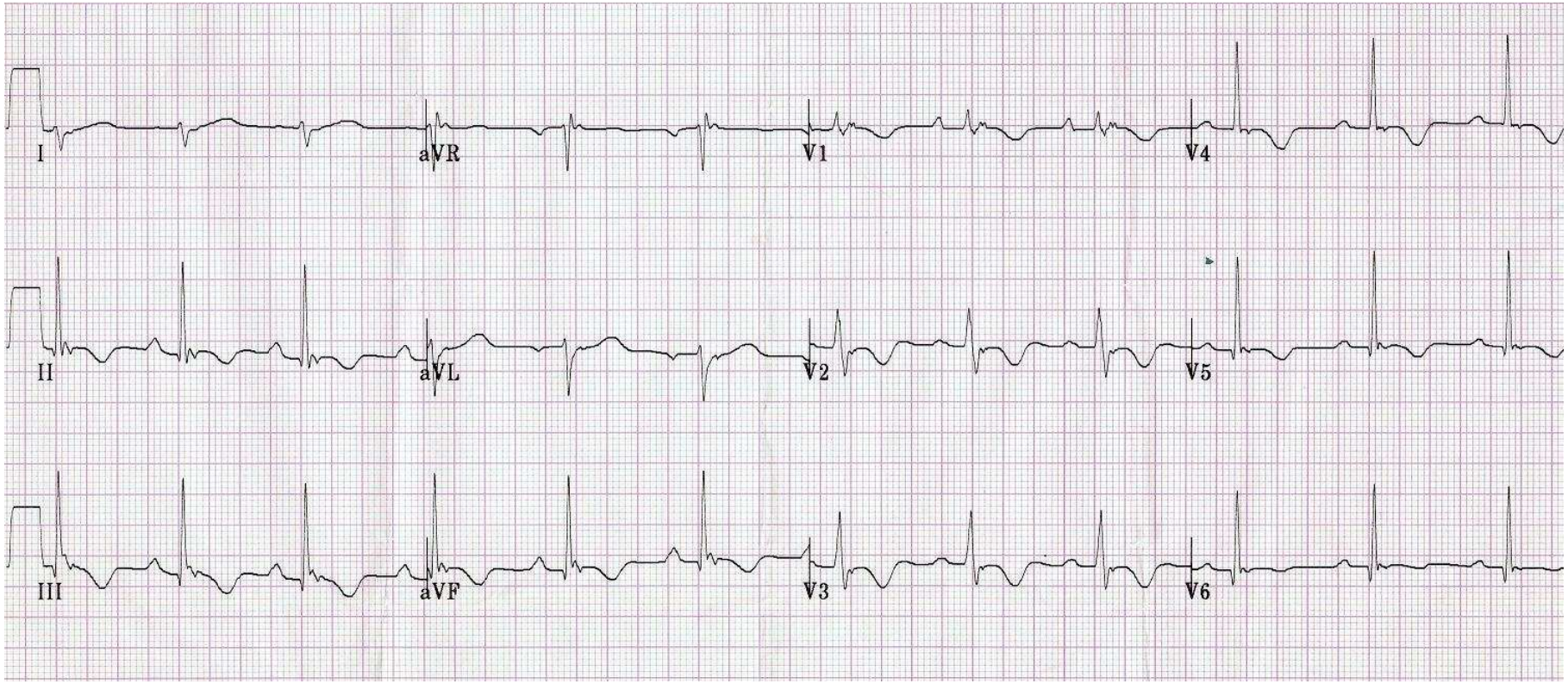


# Ableitung V1: Epsilon-Welle

**V1**

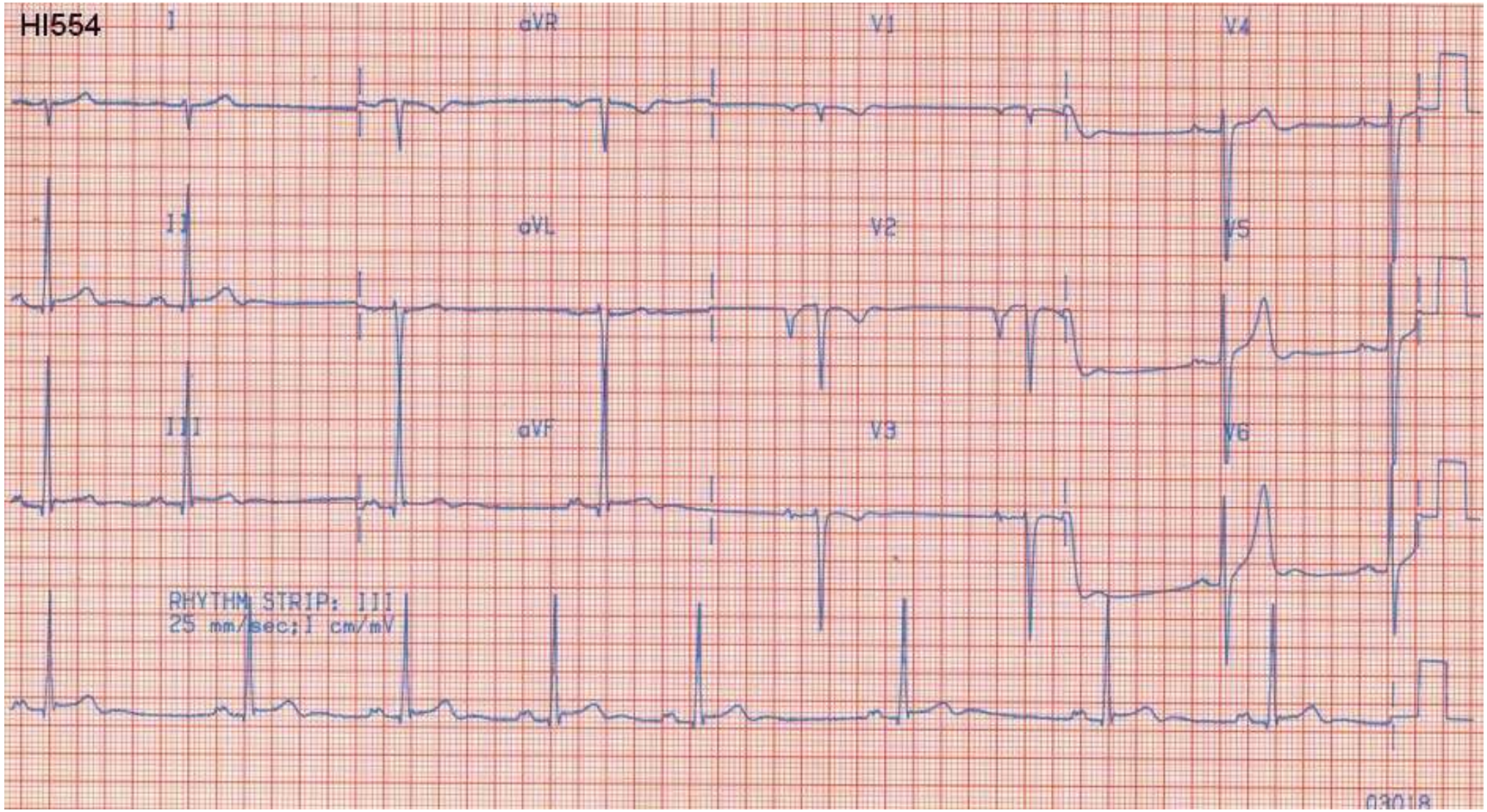


# Arrhythmogene rechtsventrikuläre Kardiomyopathie

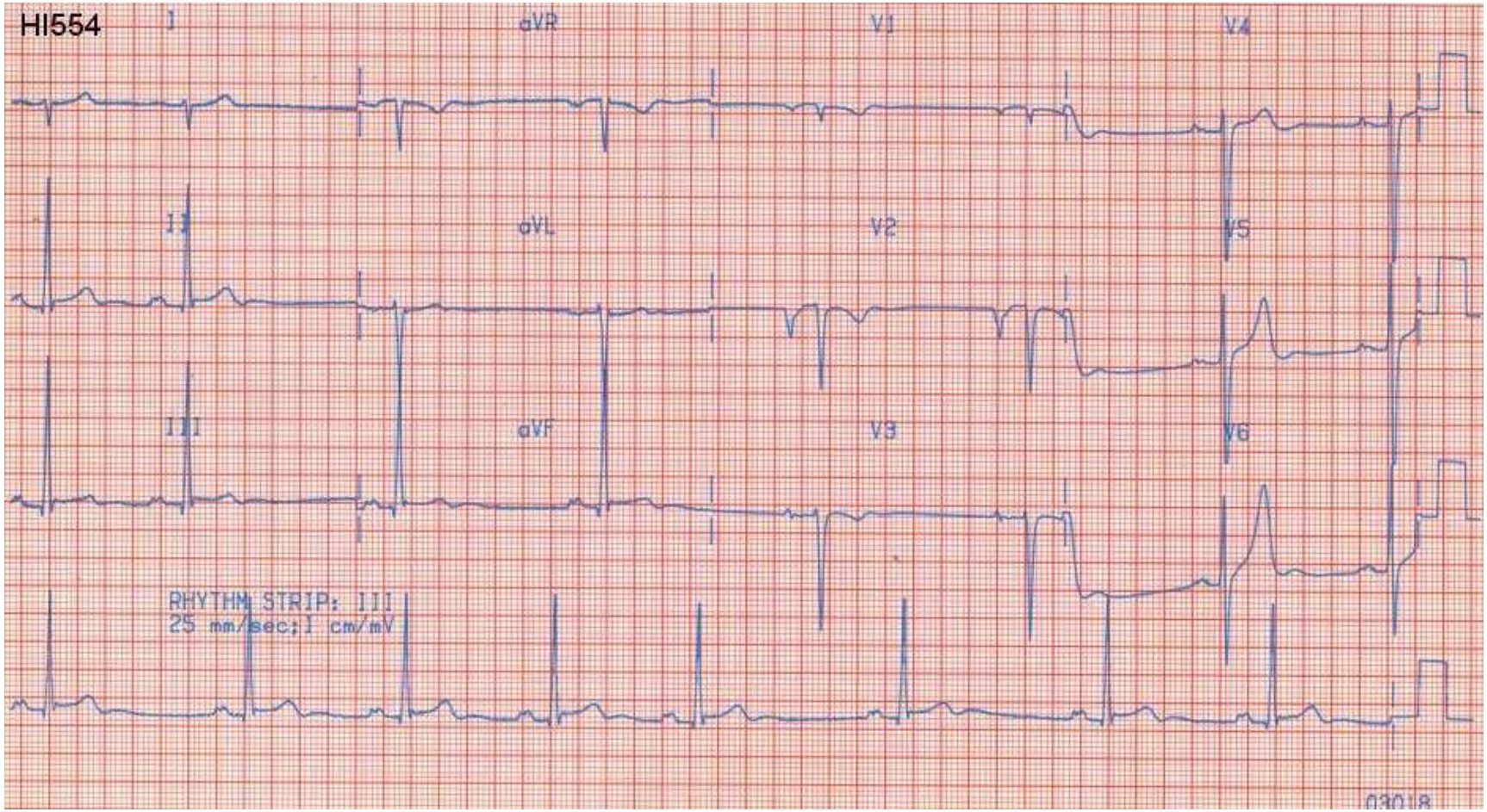



lifeinthefastlane.com

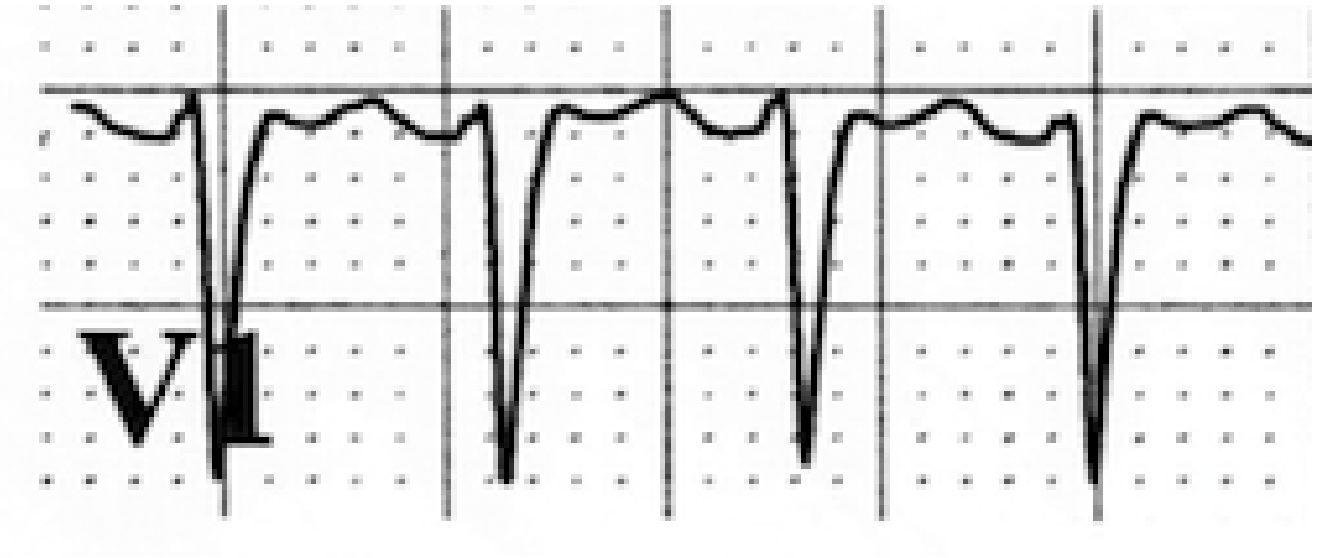
# Rechtspräkordiale Ableitungen: ?



# T-Inversion rechtspräkordial bei Trichterbrust



# Ableitung V1: Verdachtsdiagnose?




25 mm/s

1 mm = 40 ms

# Ableitung V1: AV-Knoten-Reentry-Tachykardie

Pseudo-R-Zacken

Fox D J et al. Mayo Clin Proc. 2008;83:1400-1411

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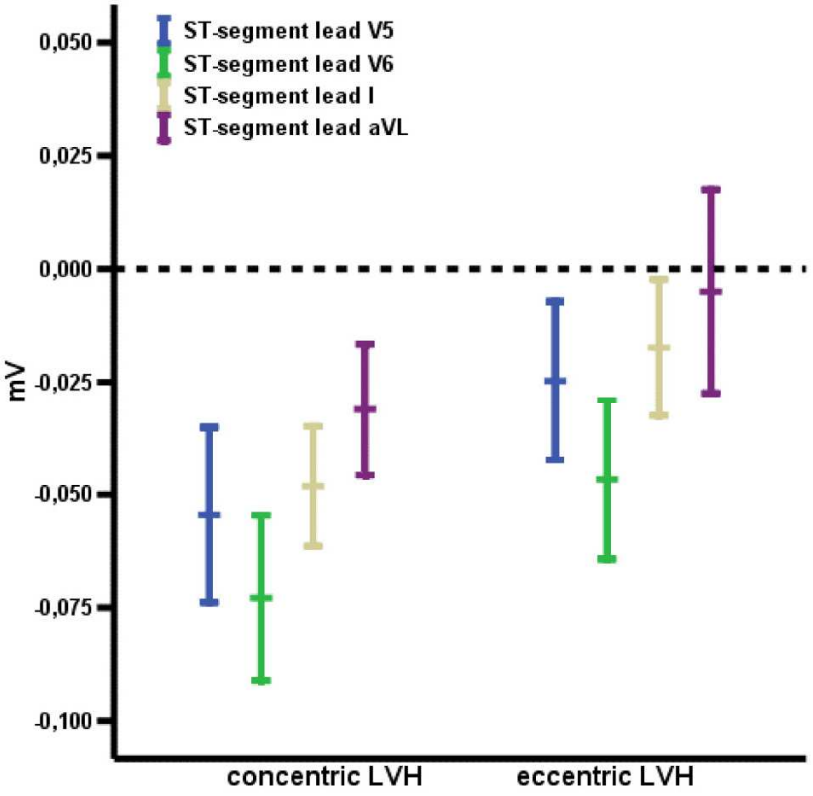
Mayo Clinic Proceedings

# Schlussfolgerungen

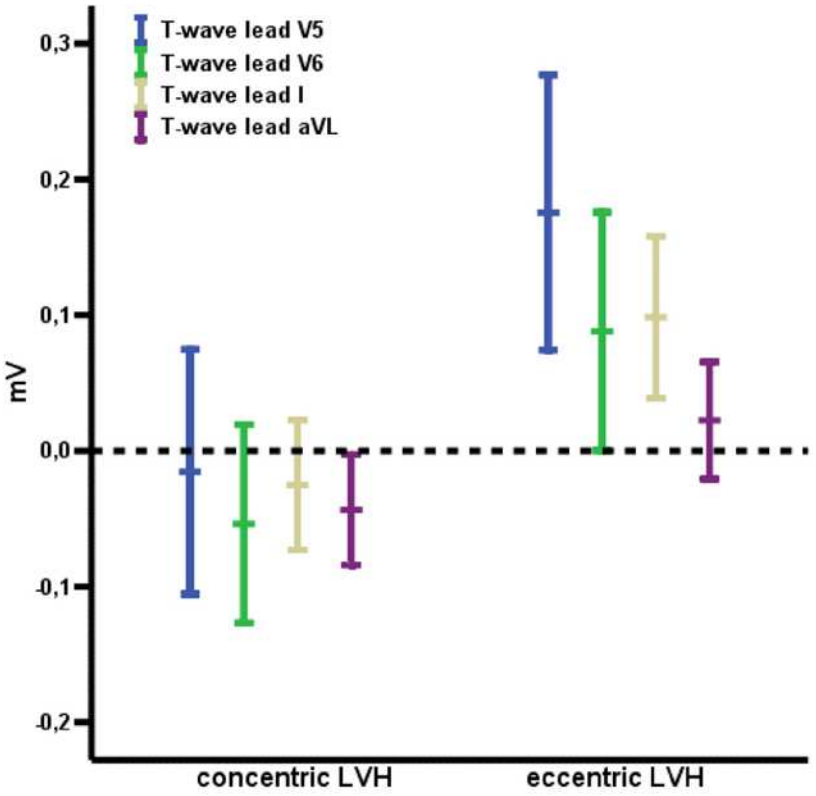
- Die mittels EKG nachgewiesene LVH ist ein unabhängiger Risikofaktor für eine erhöhte Morbidität und Mortalität
- Die Bedeutung von komplexen LVH-Mustern (Amplituden-zunahme, QRS-Verbreiterung, Repolarisationsstörungen) ist bislang nicht ausreichend untersucht.
- Mustererkennung spielt insgesamt eine wichtige Rolle bei der EKG-Diagnostik.
- Für die sinnvolle Anwendung des EKGs ist ein Grundwissen der kardialen Physiologie/Pathophysiologie notwendig.

# ST/T: konzentrische und exzentrische LV-Hypertrophie

**Konzentrische LVH**




**Exzentrische LVH**




Buchner et al. 2009