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Cardiovascular Sequence

Electrocardiogram

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Fall 2012

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Grants: NIH, Hewlett Foundation,

Mardigian Foundation, Varbedian Fund, GORE

Consultant: NIH NHLBI

Electrocardiogram

Key Words: Depolarization, repolarization, EKG leads, electrical axis, ST segment shifts

Objectives:

1. To learn the nomenclature and classification system for ECG interpretation.
2. To learn the major conduction abnormalities seen on ECG interpretation.
3. To diagnose ischemic heart disease patterns on ECG's.
4. To become familiar with how structural heart conditions affect ECG findings.

Electrocardiogram

The Normal EKG: Outline

Electrical Measurement - Single Cell

EKG Reference System

- Technical Considerations
- Sequence of Activation

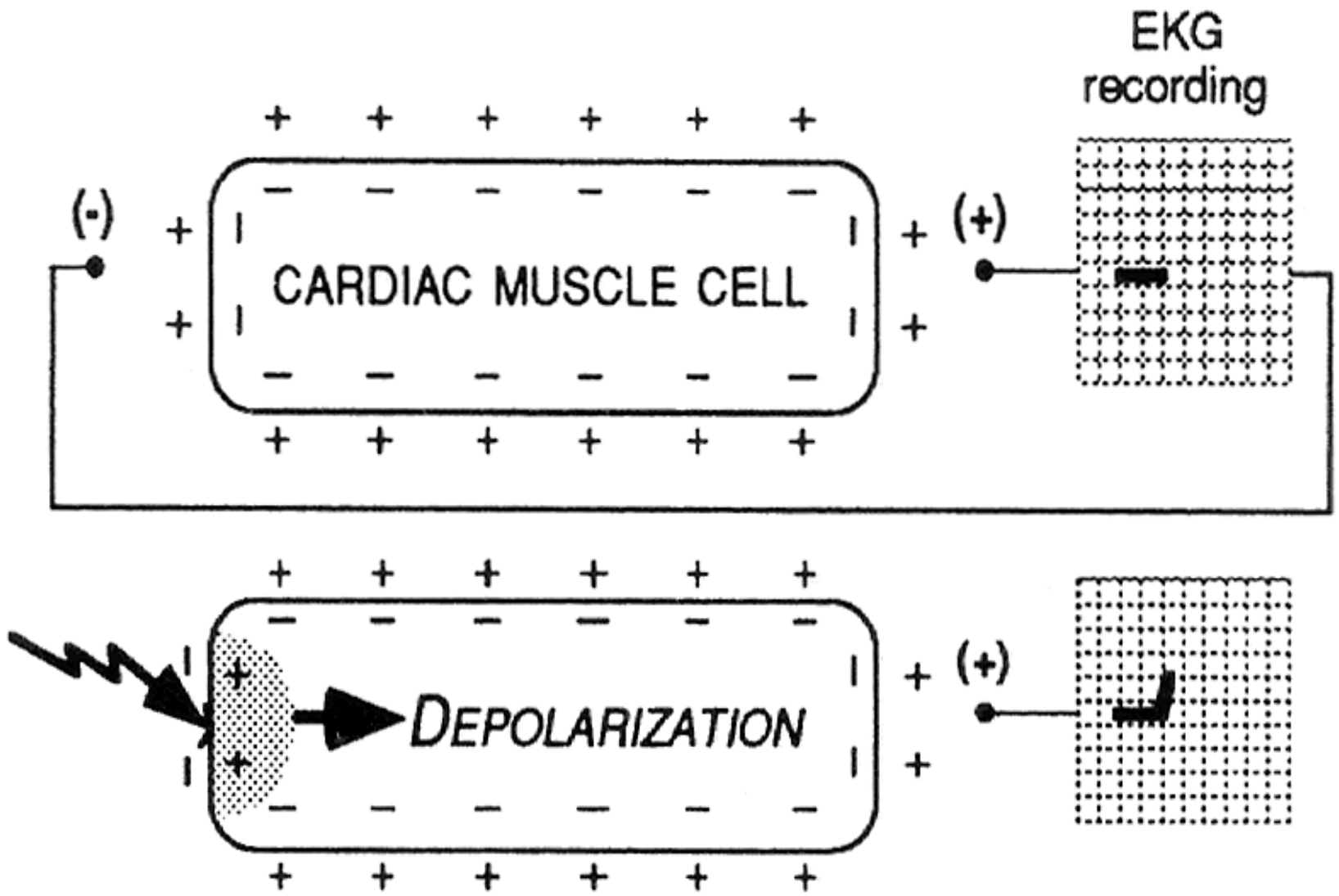
Interpretation

- Calibration
- Rhythm
- Rate
- Intervals
- QRS Axis
- P-waves
- QRS
- ST-T wave abnormalities

Electrical Measurement Single Cell

Key Concepts

- Resting state - polarized
- Depolarization
- Repolarization
- Directionality



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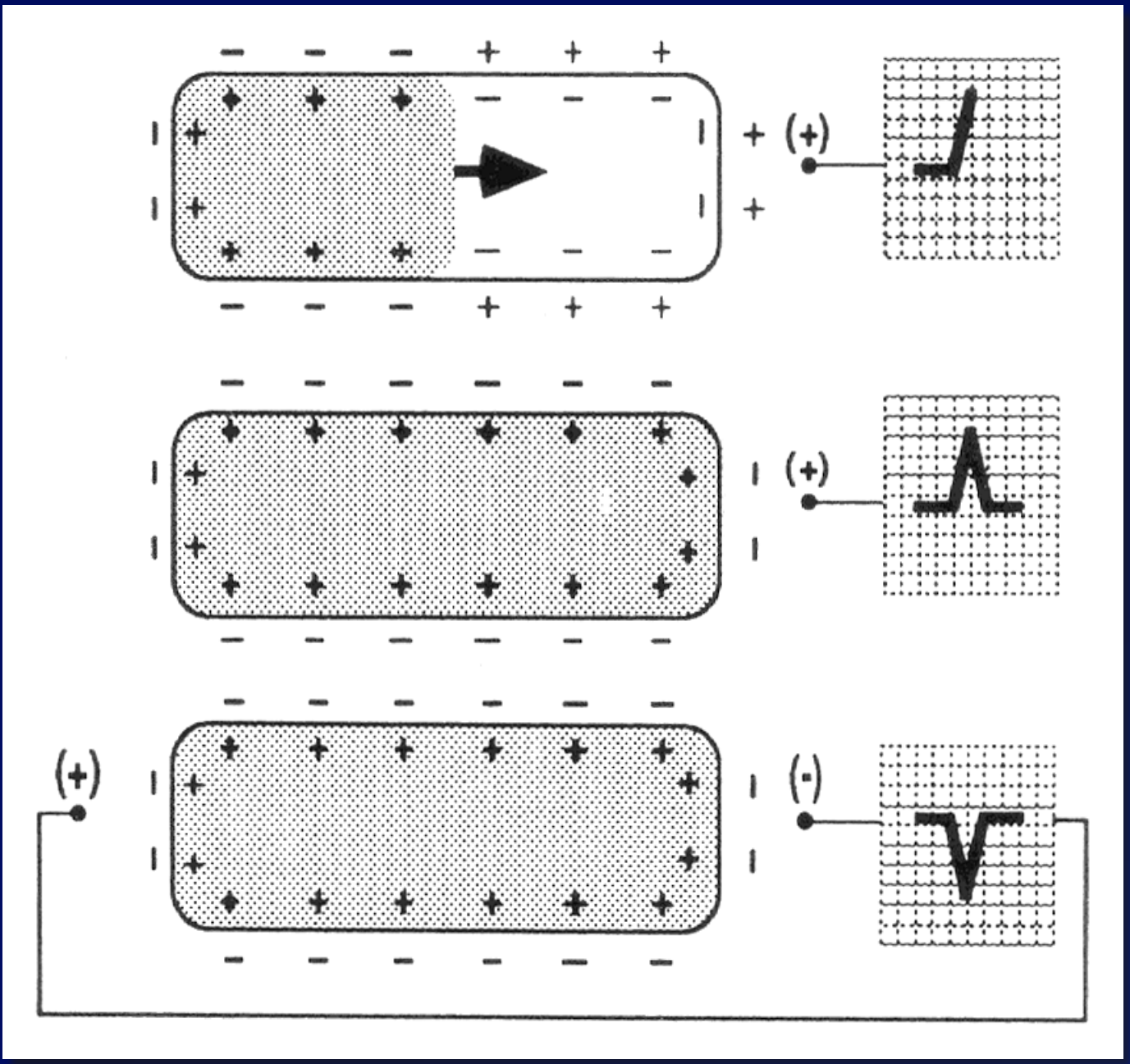

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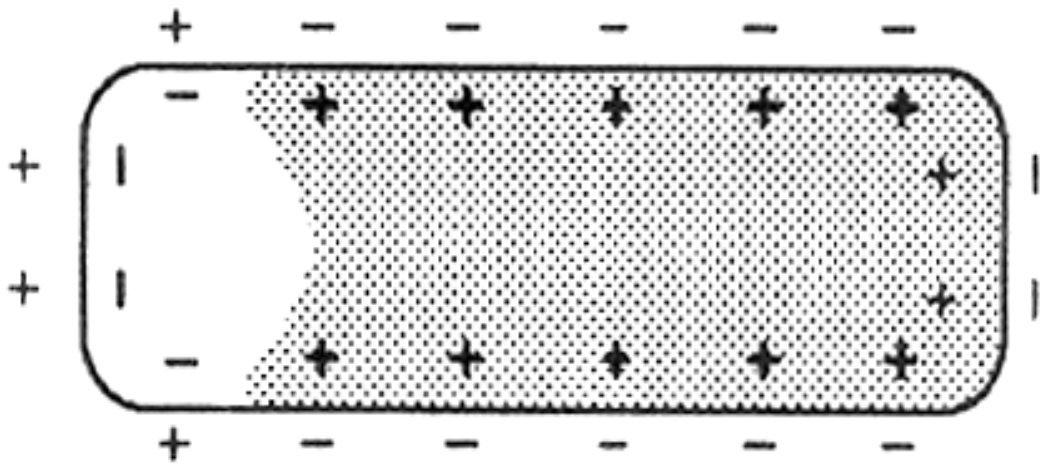

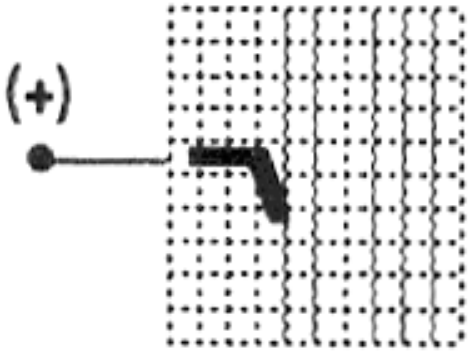

Depolarized portion

Repolarized portion

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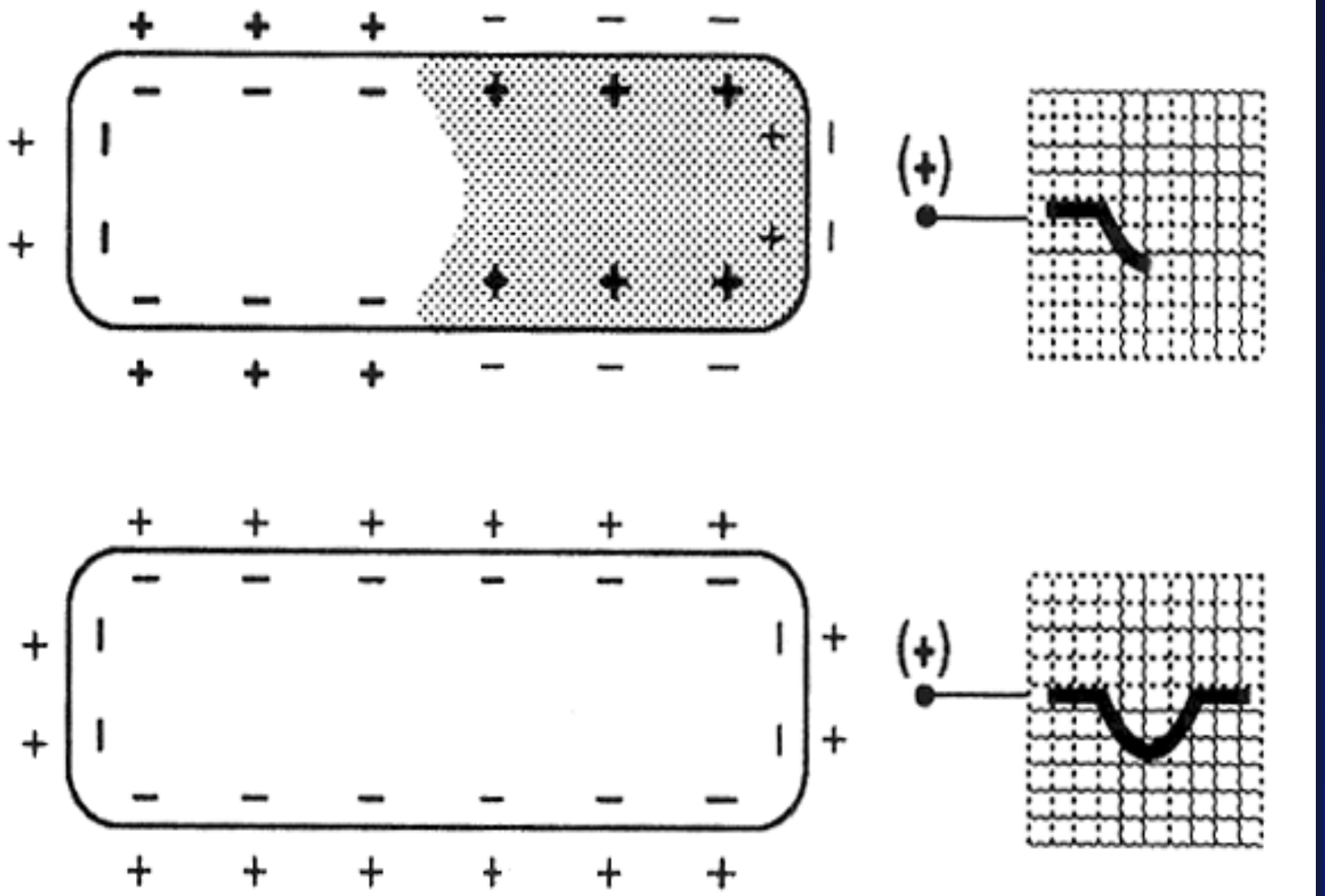

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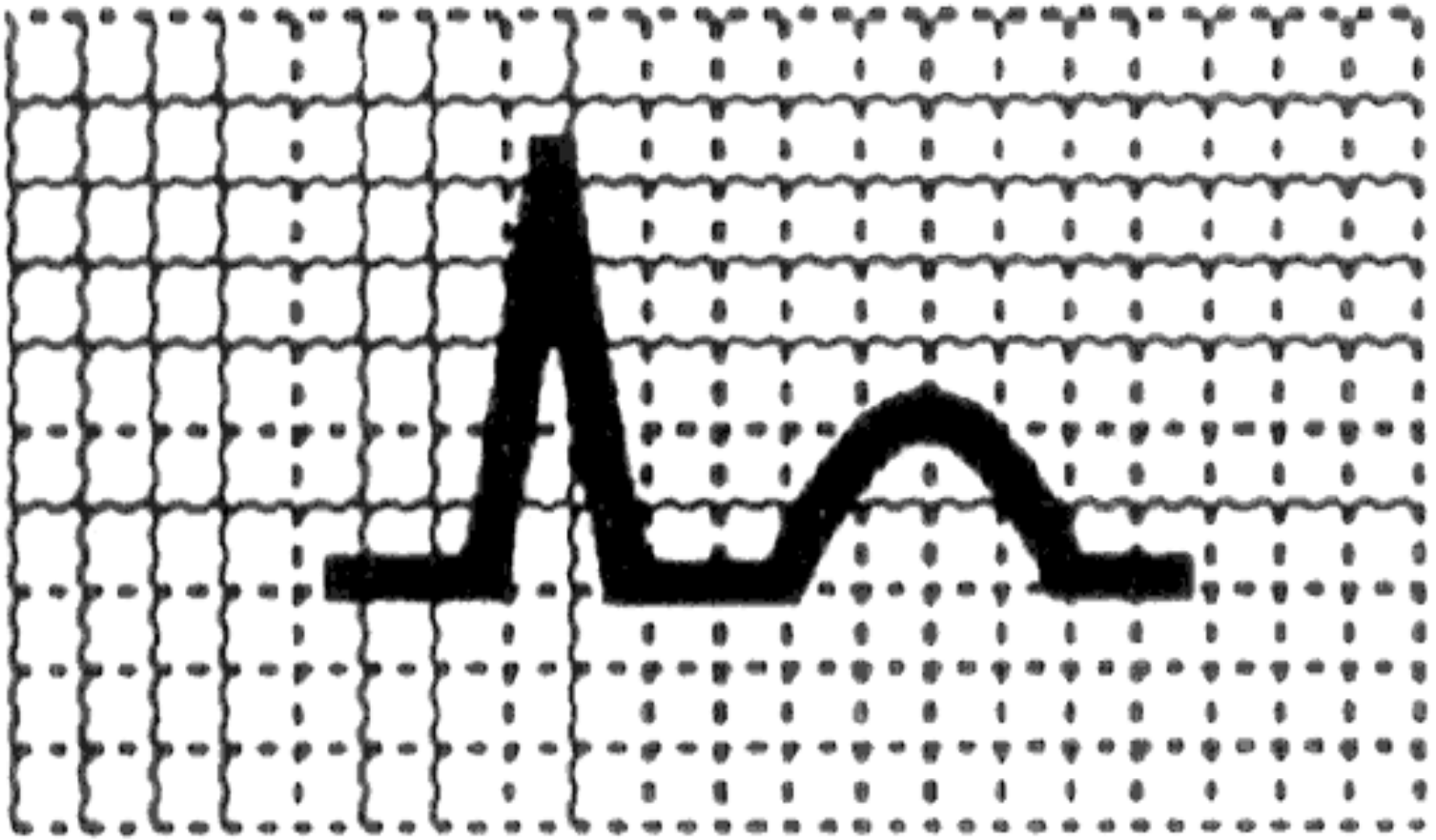

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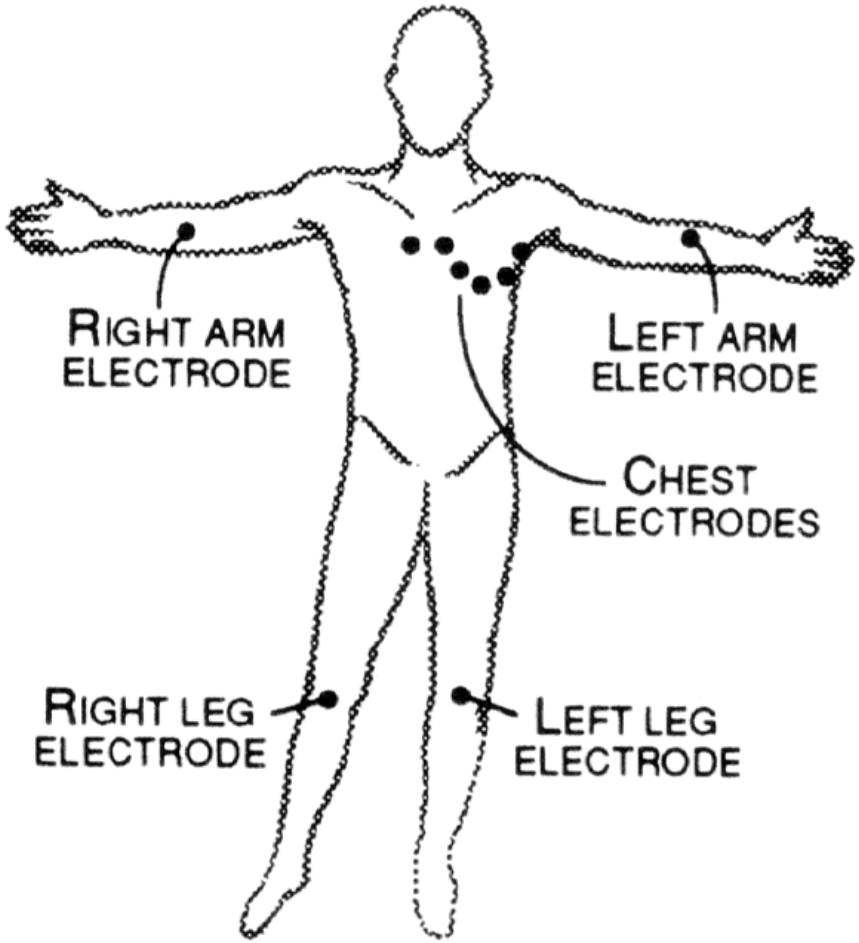
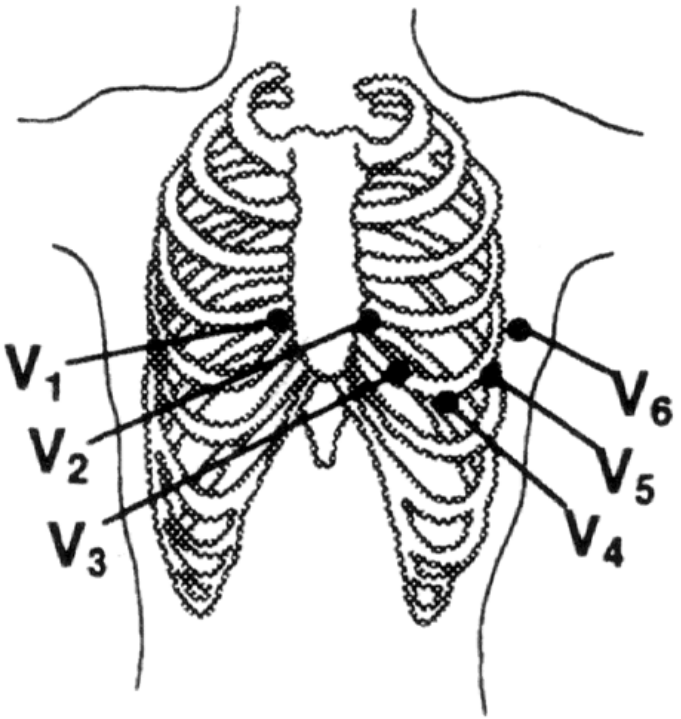
EKG Lead Reference System

- Unipolar
- Bipolar
- Chest Leads





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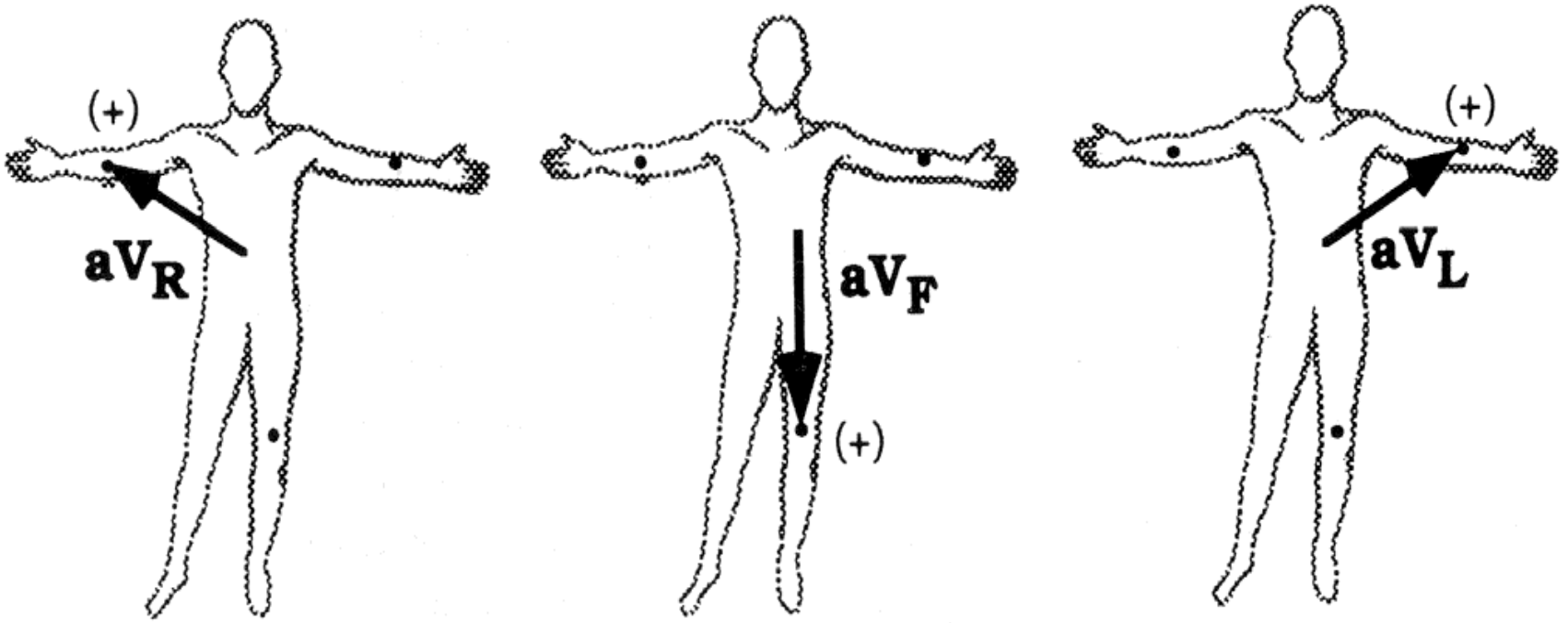
Unipolar Limb Leads



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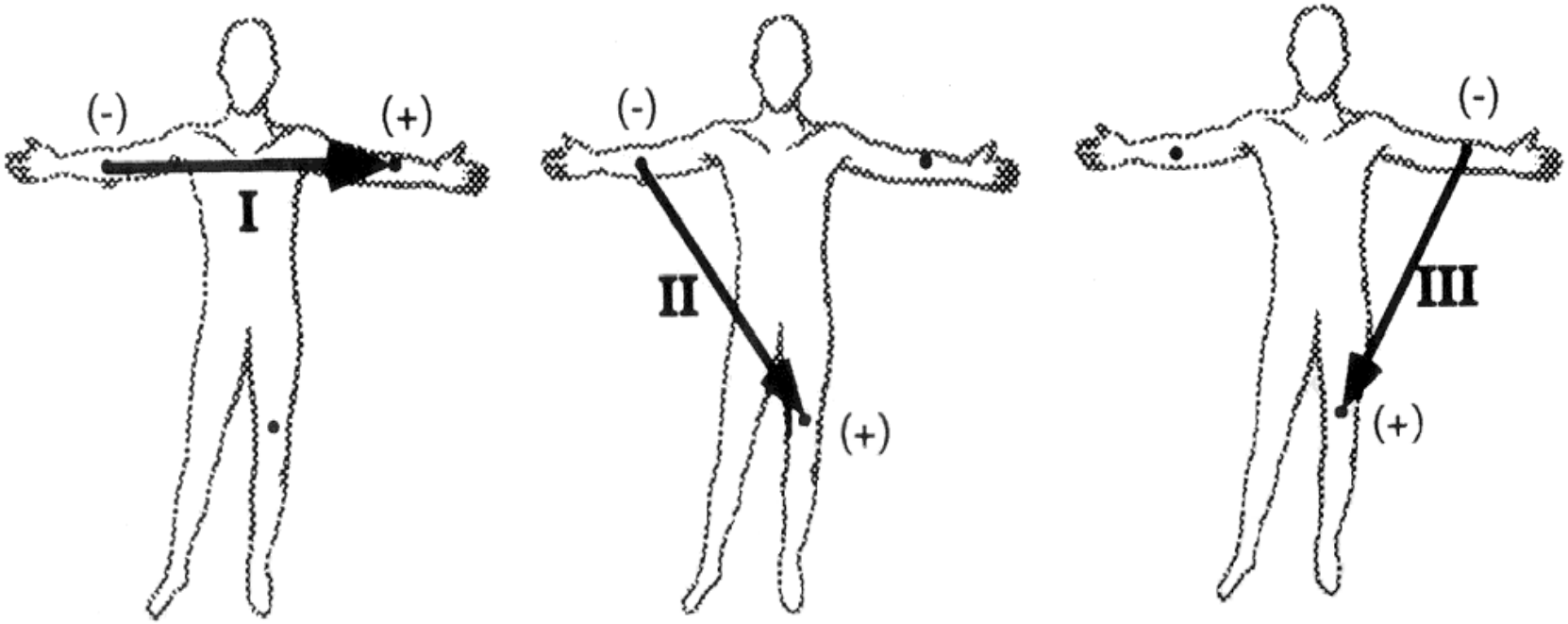
Bipolar Limb Leads



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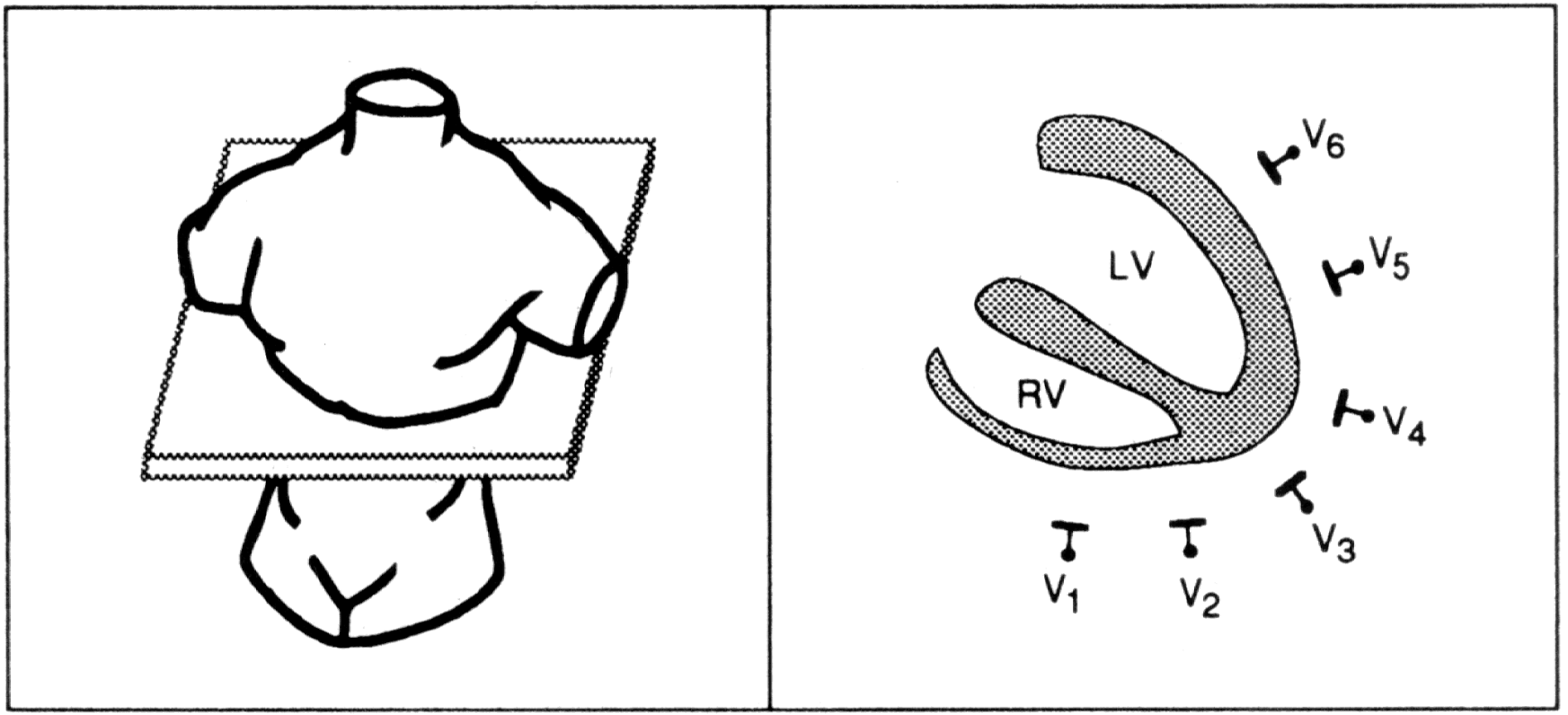

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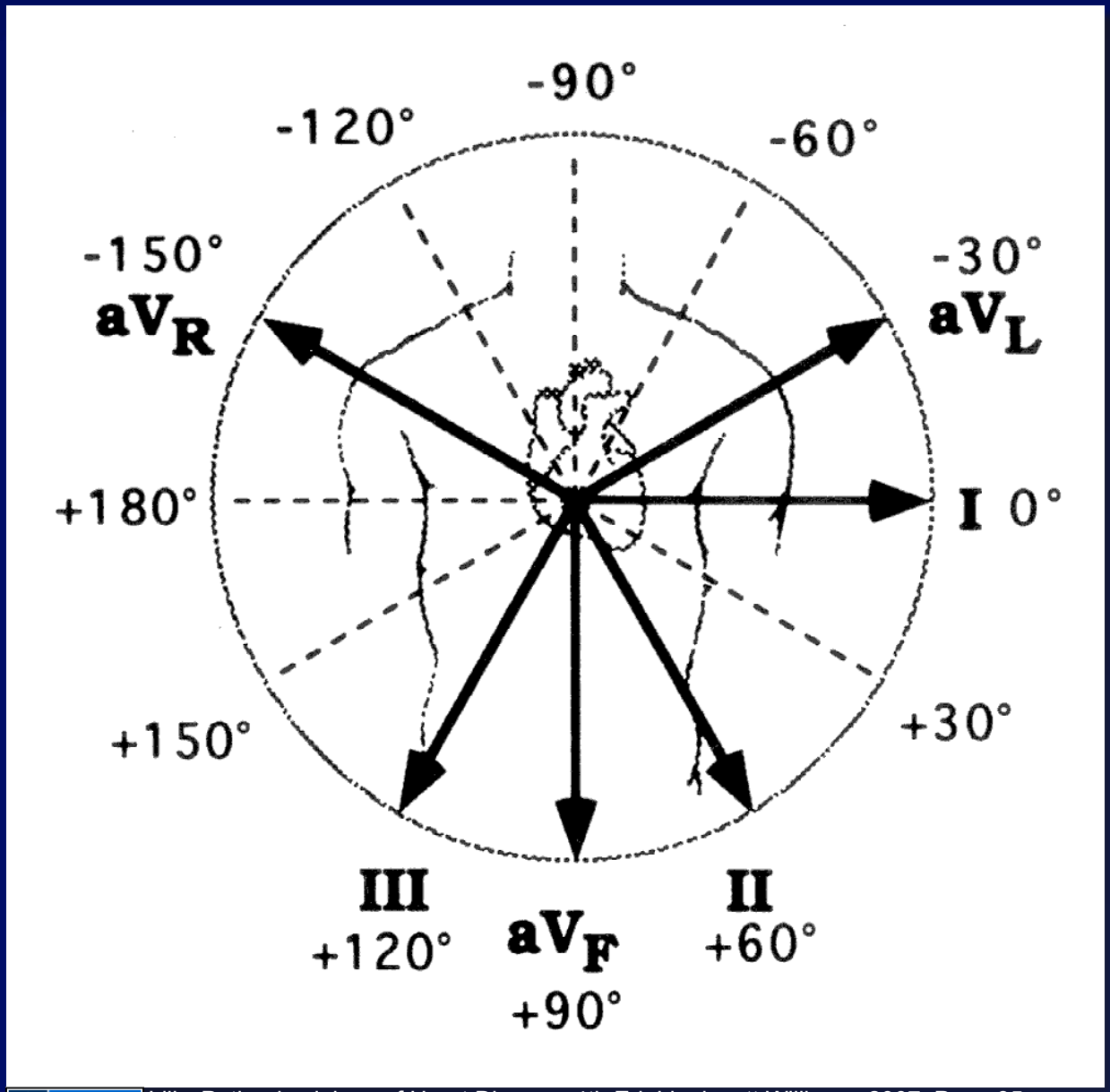

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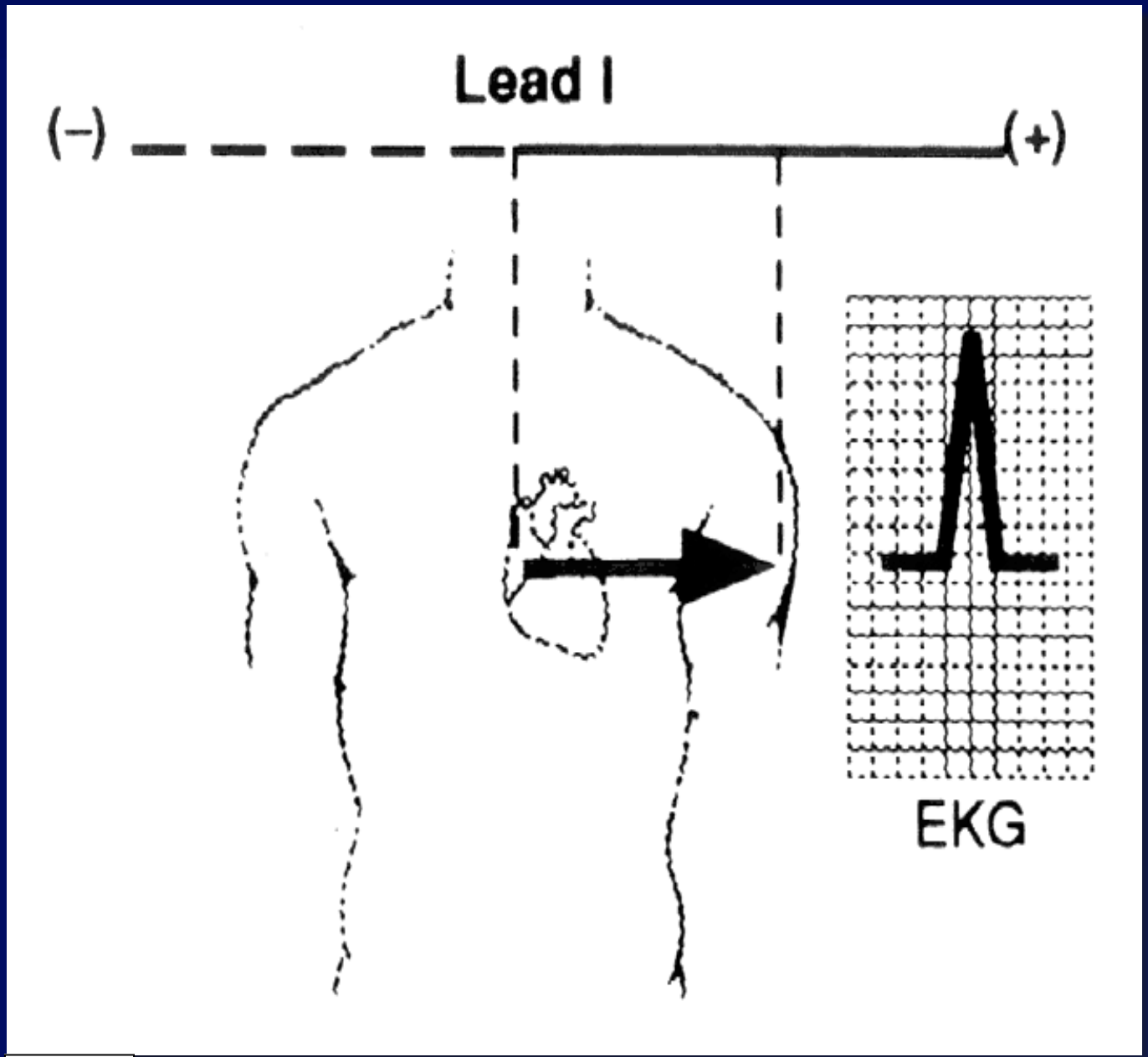
Magnitude and Direction of Electrical Activity

Key Principles:

- Electrical force directed at (+) pole of a lead generates upward EKG deflection
- Forces directed away from (+) pole generate downward deflection
- Magnitude of deflection reflects how parallel the electrical force to lead
- Forces directed perpendicular to a lead generate no activity or flat line



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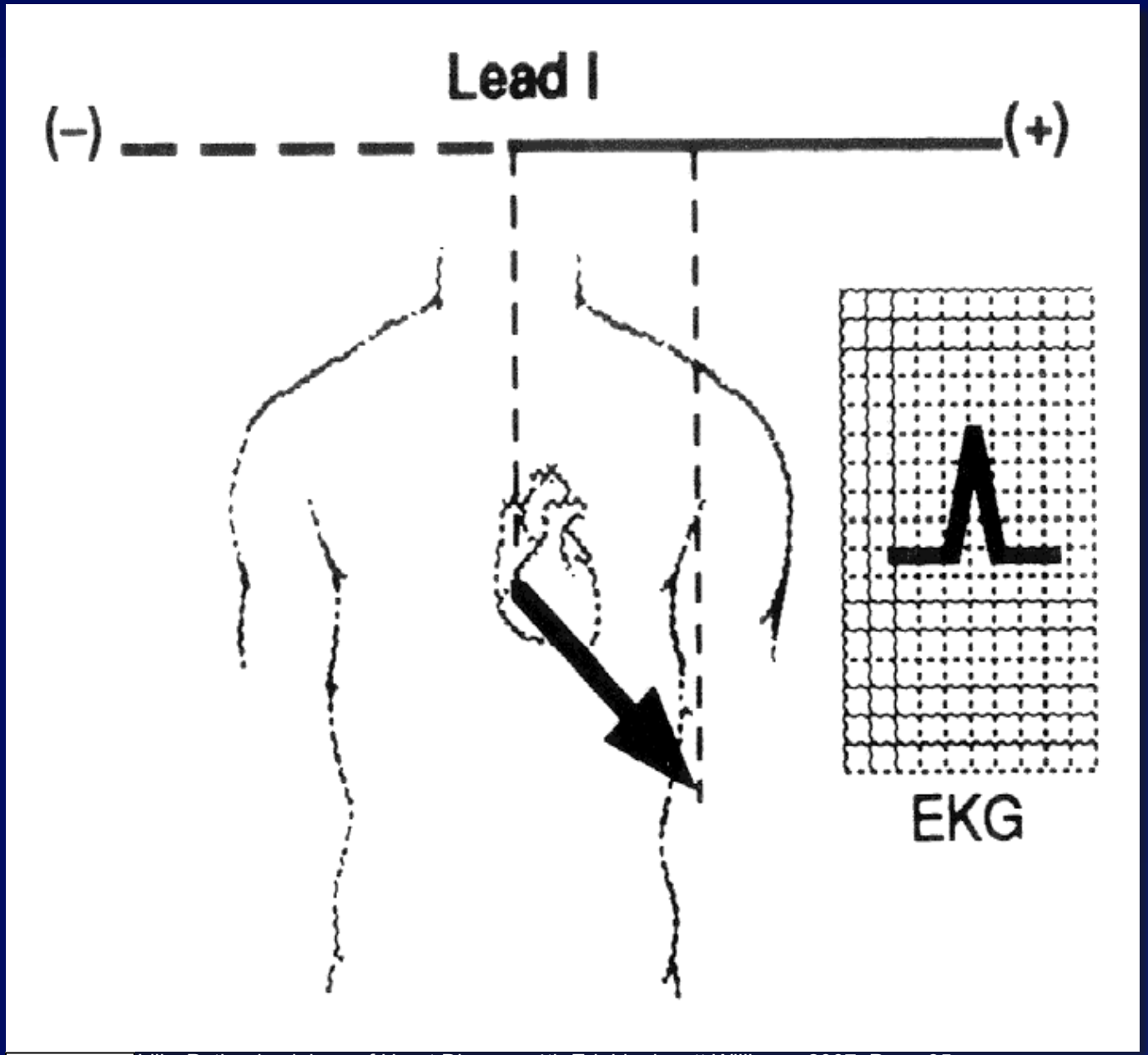

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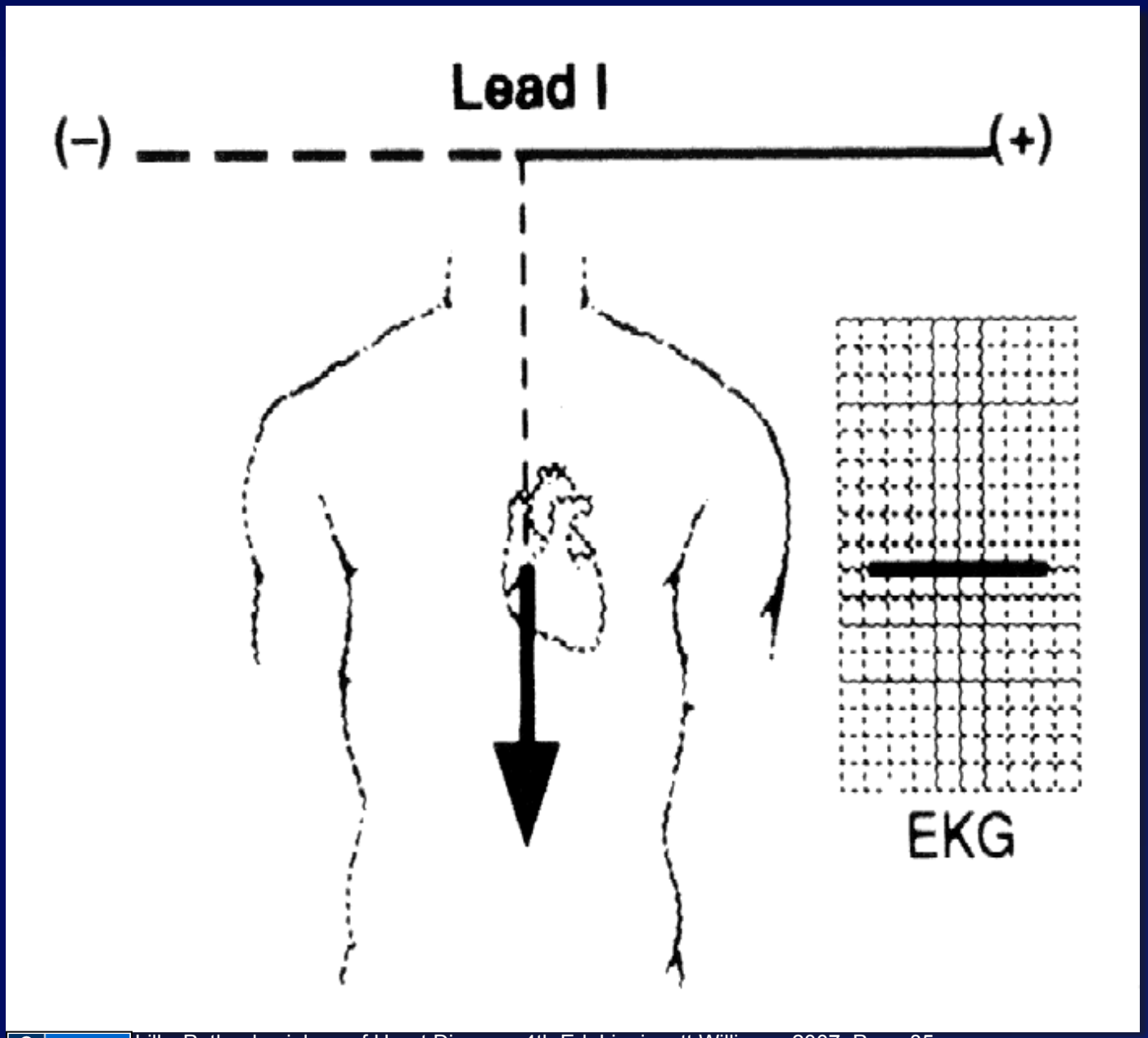

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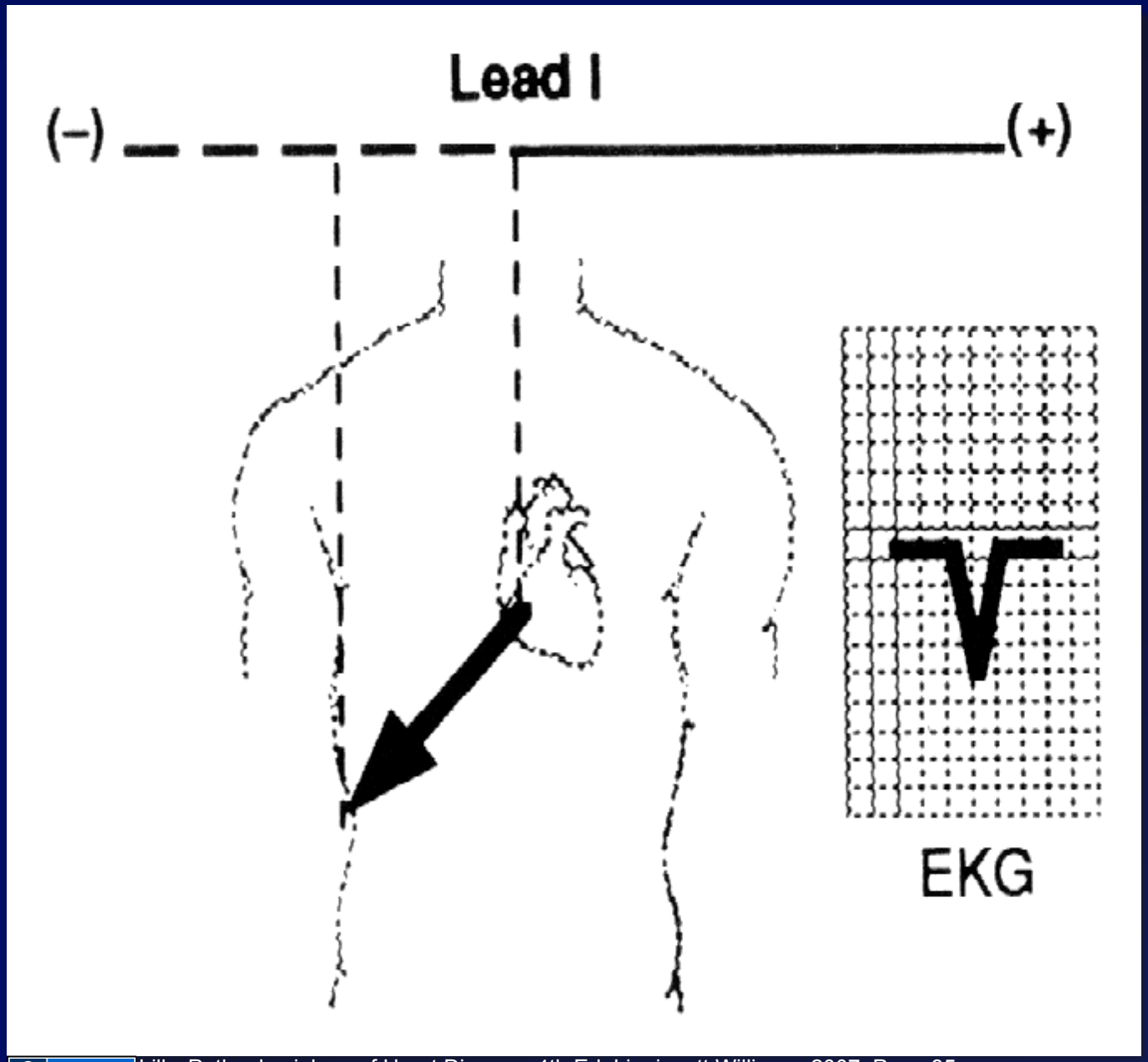

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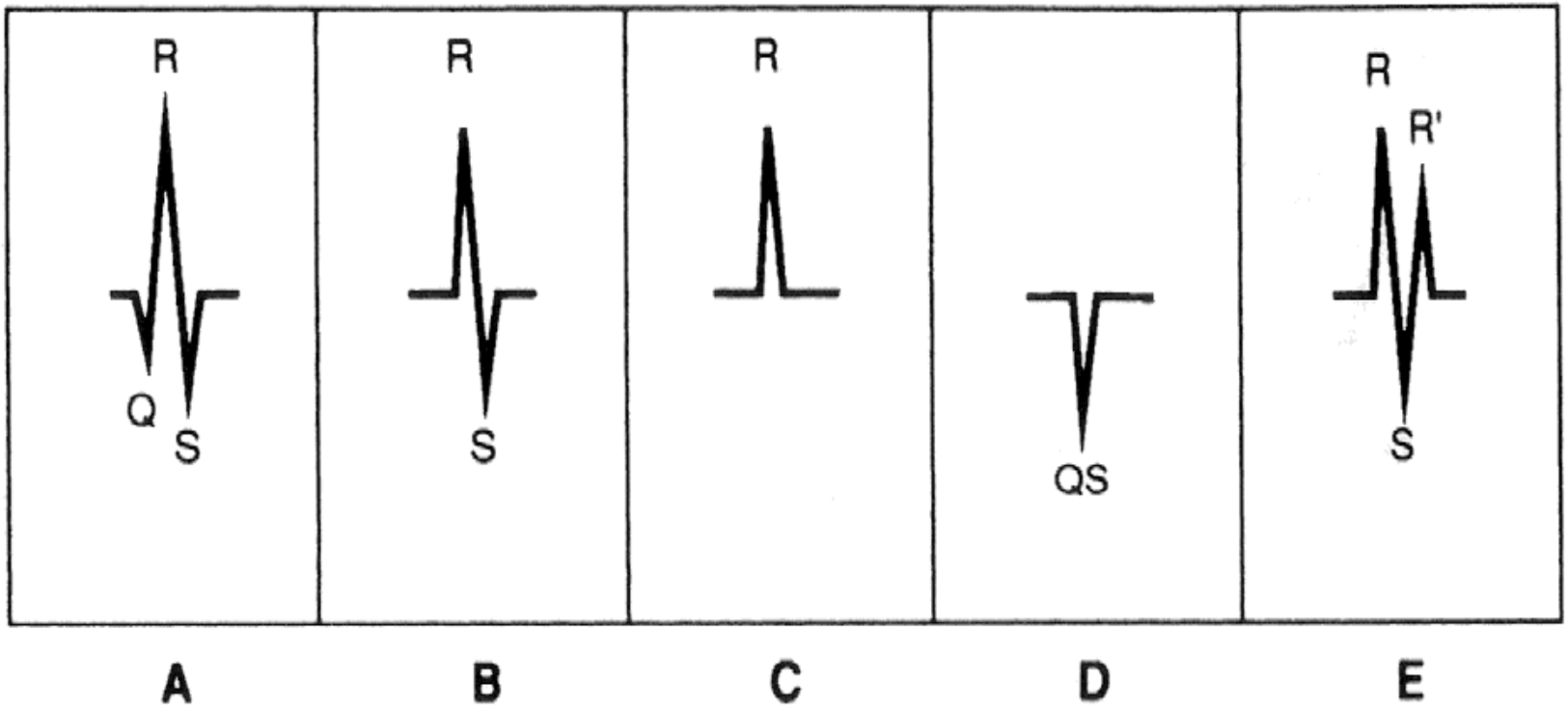

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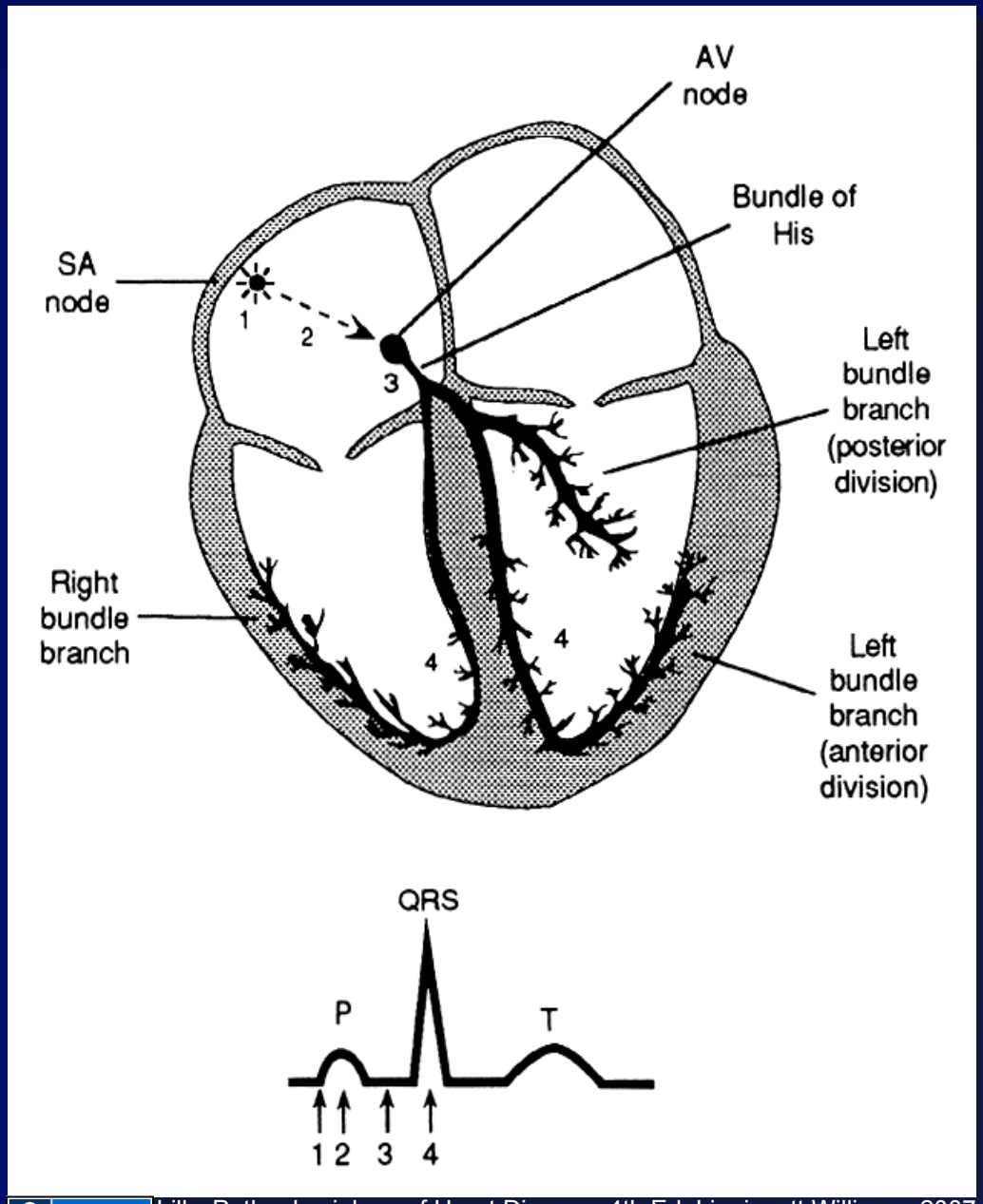
Sequence of Normal Cardiac Activation



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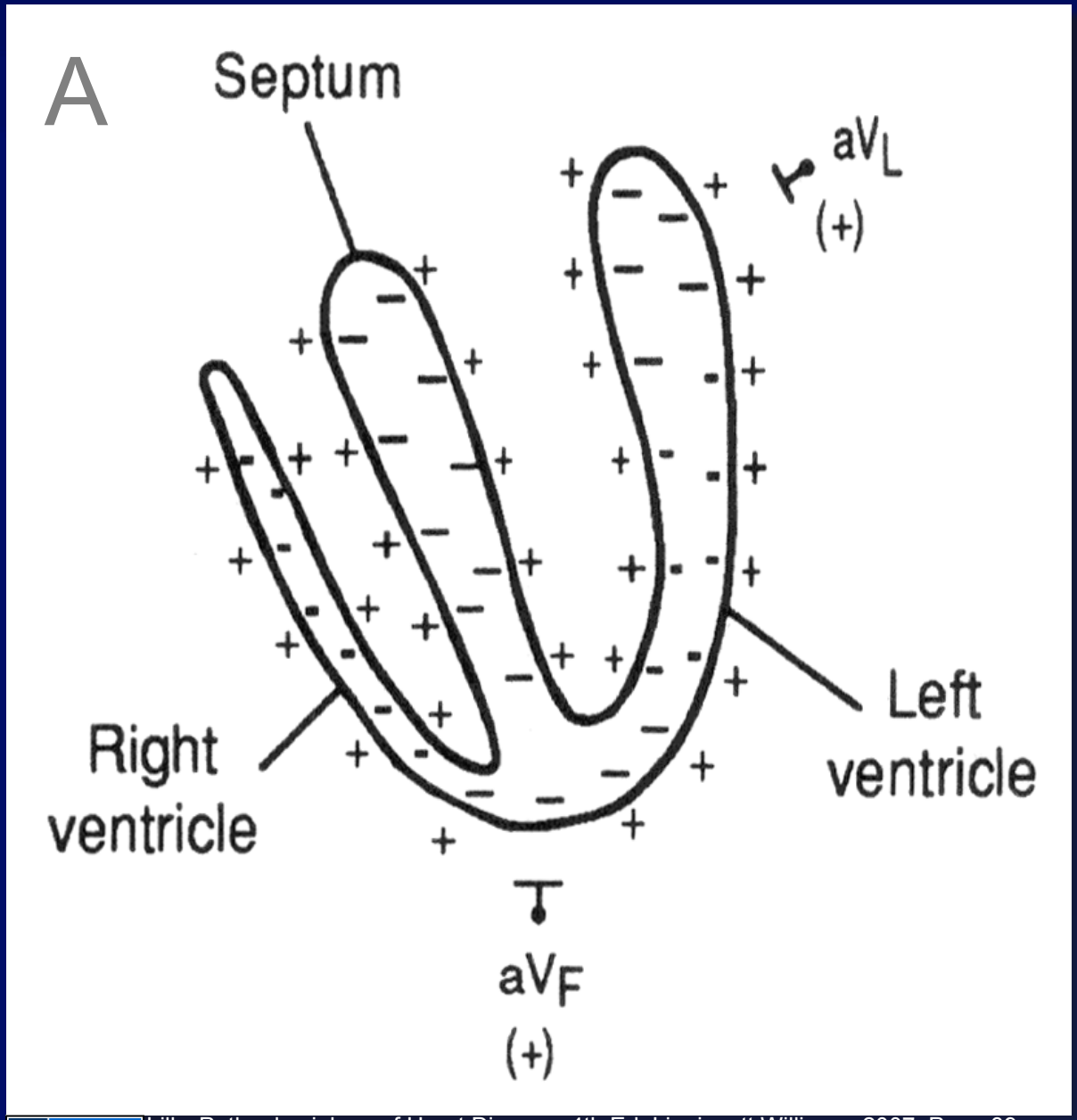

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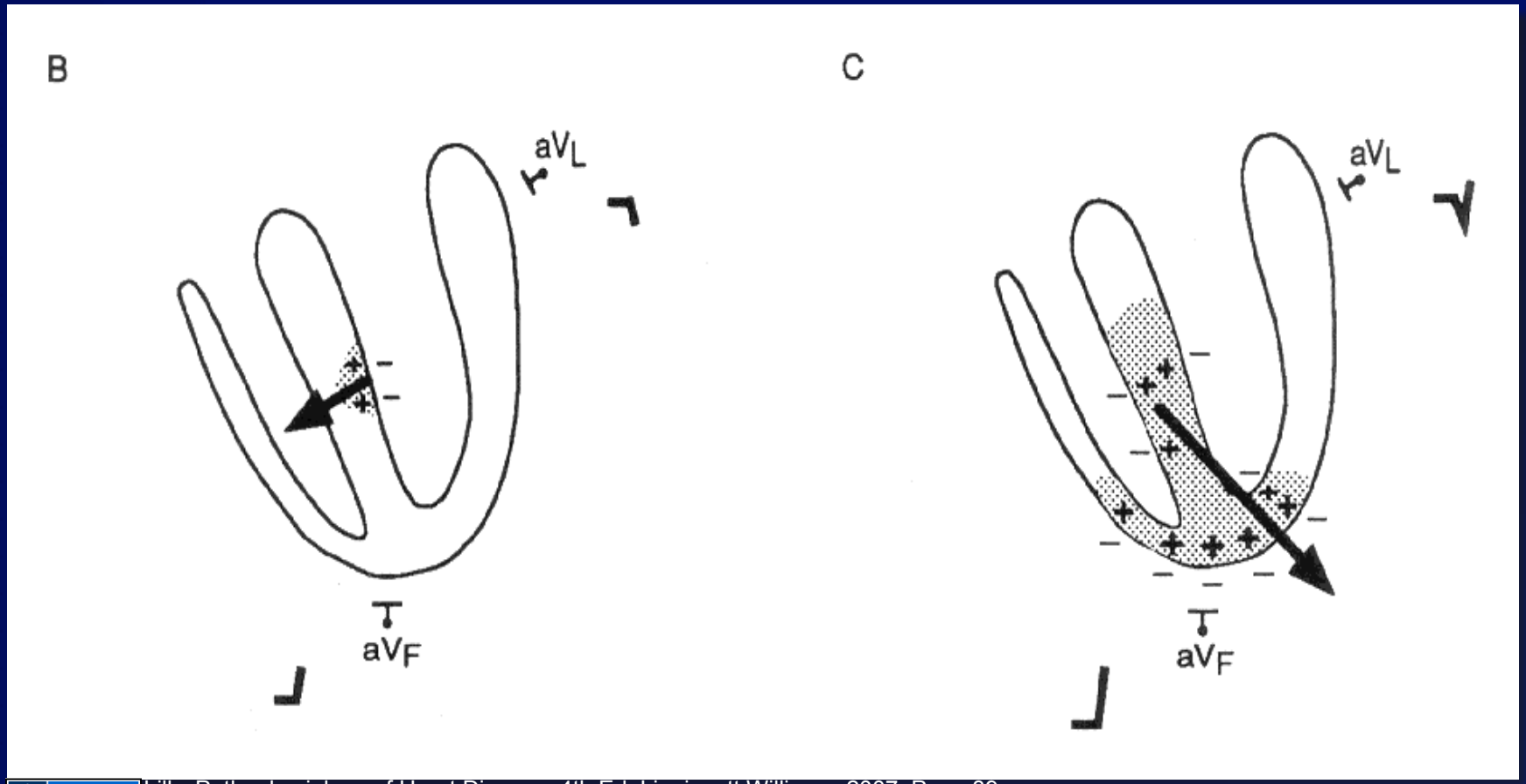

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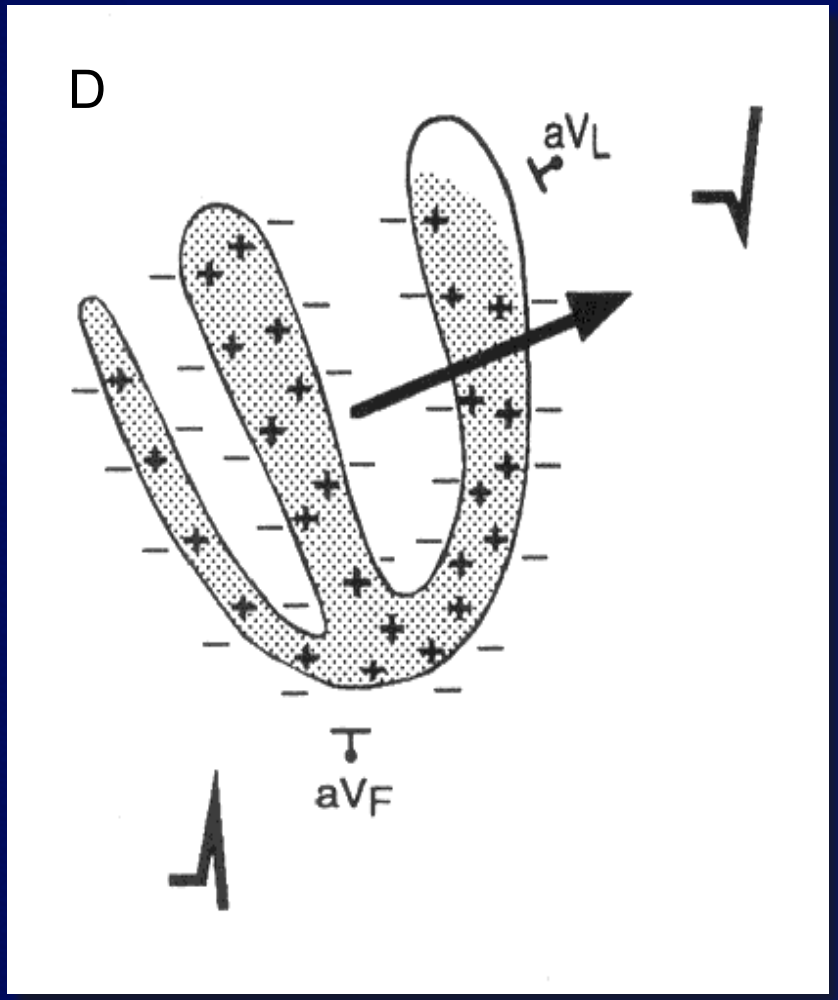

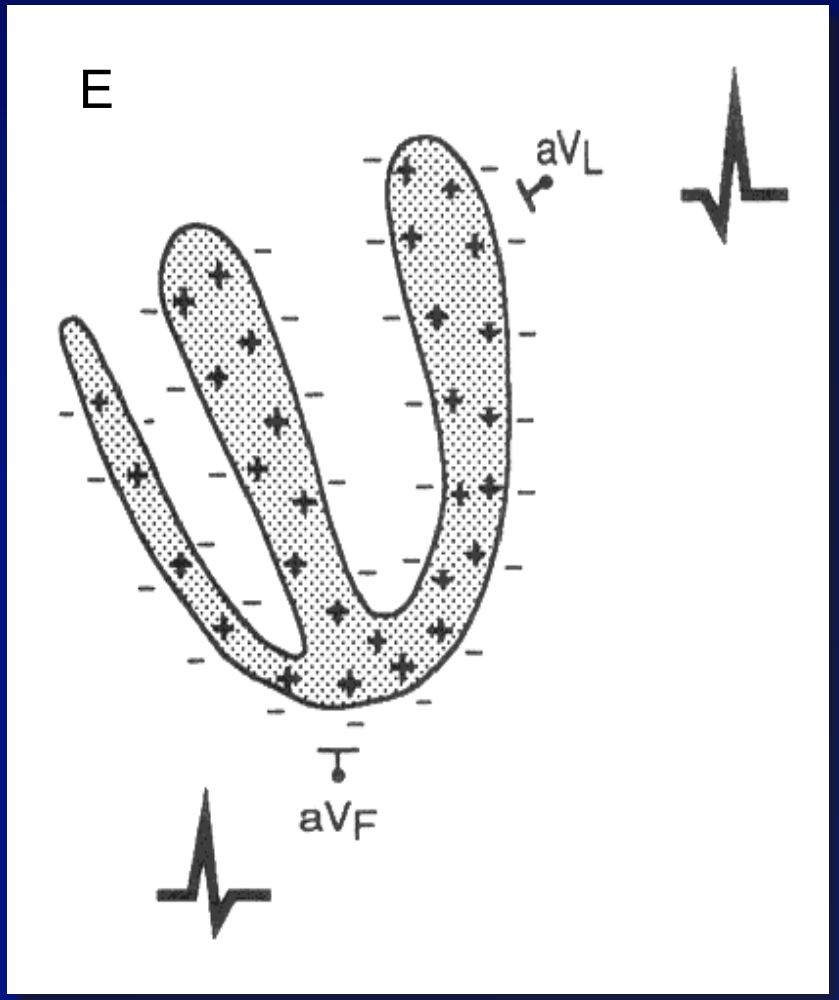

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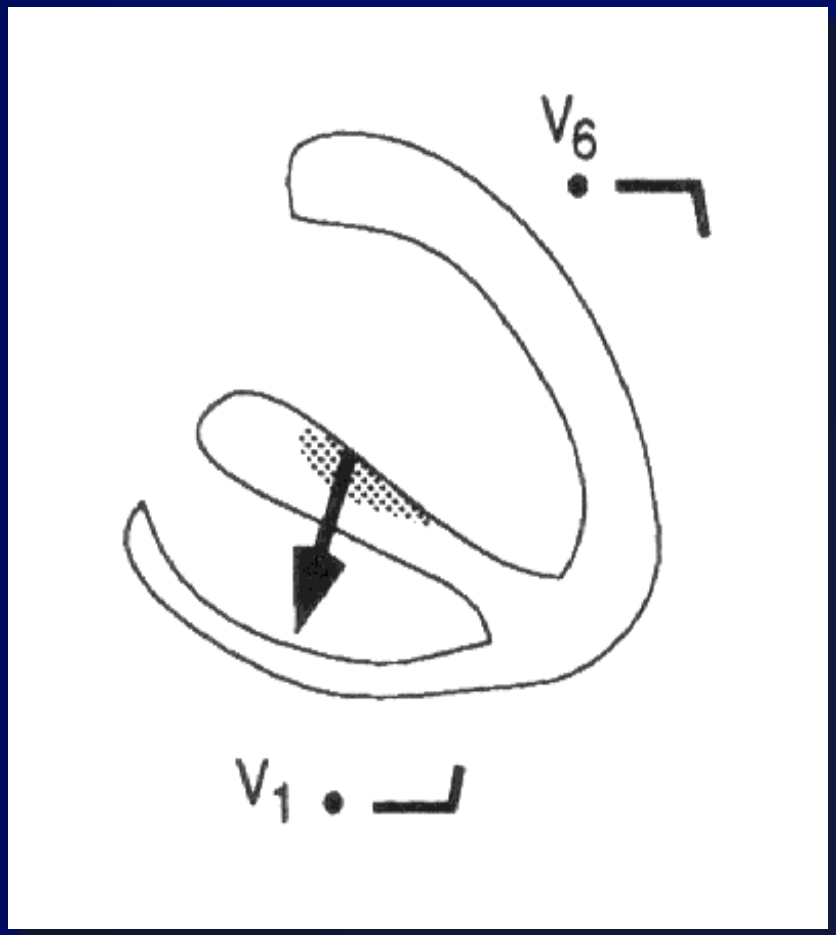

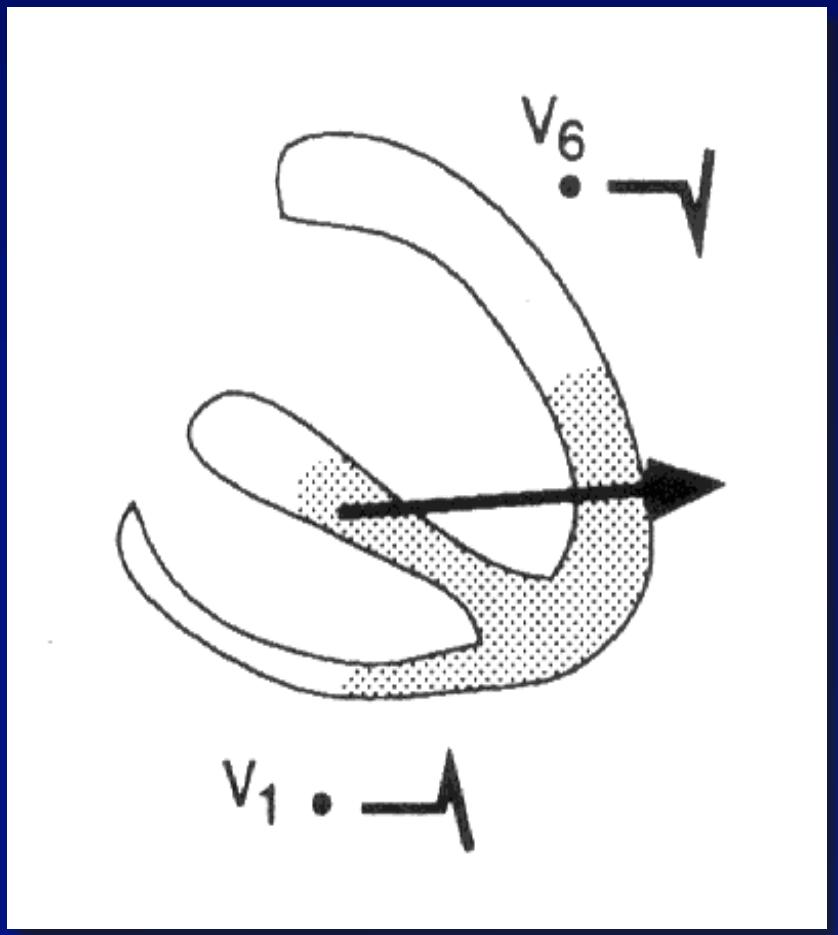

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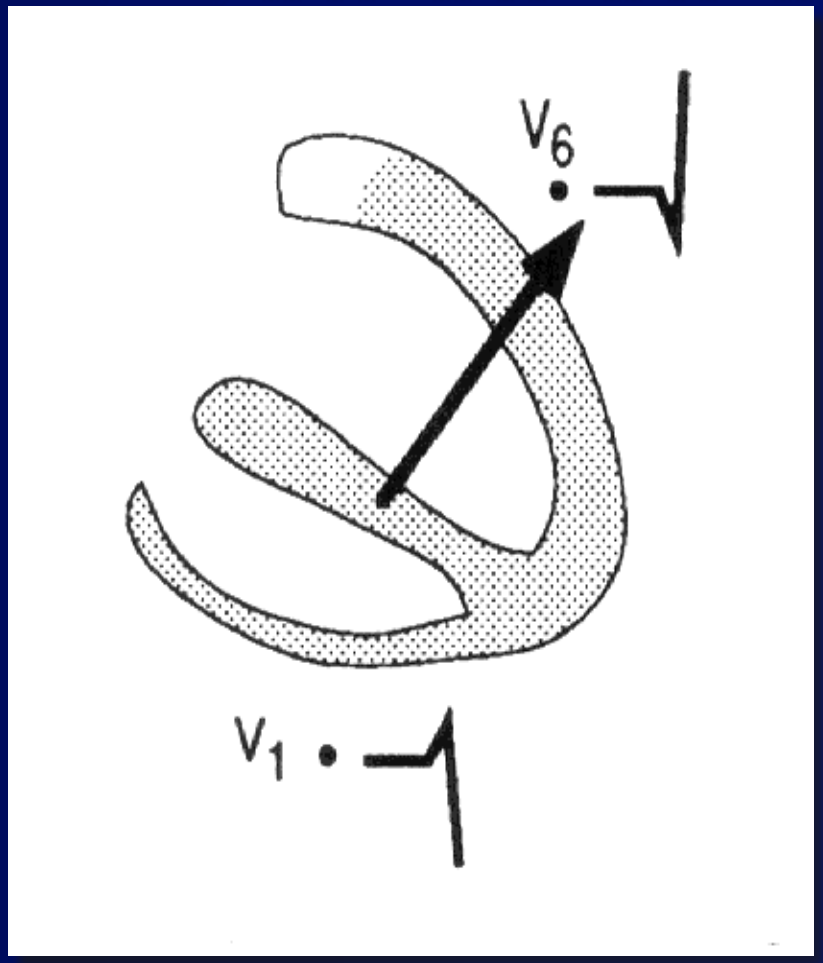

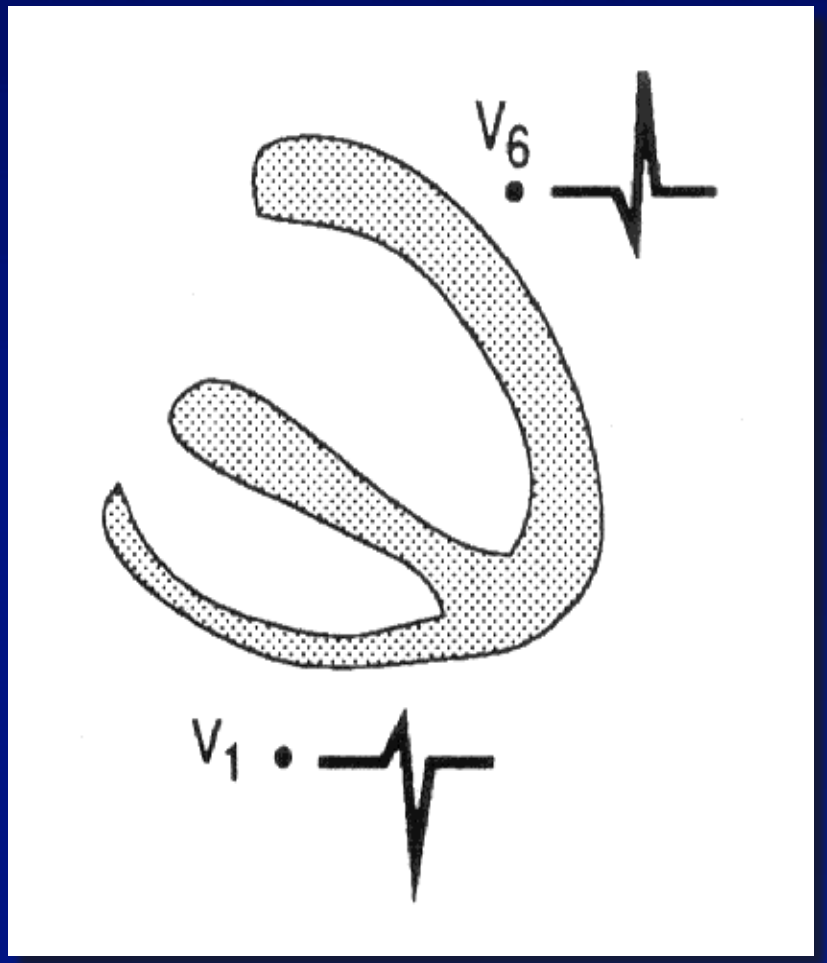

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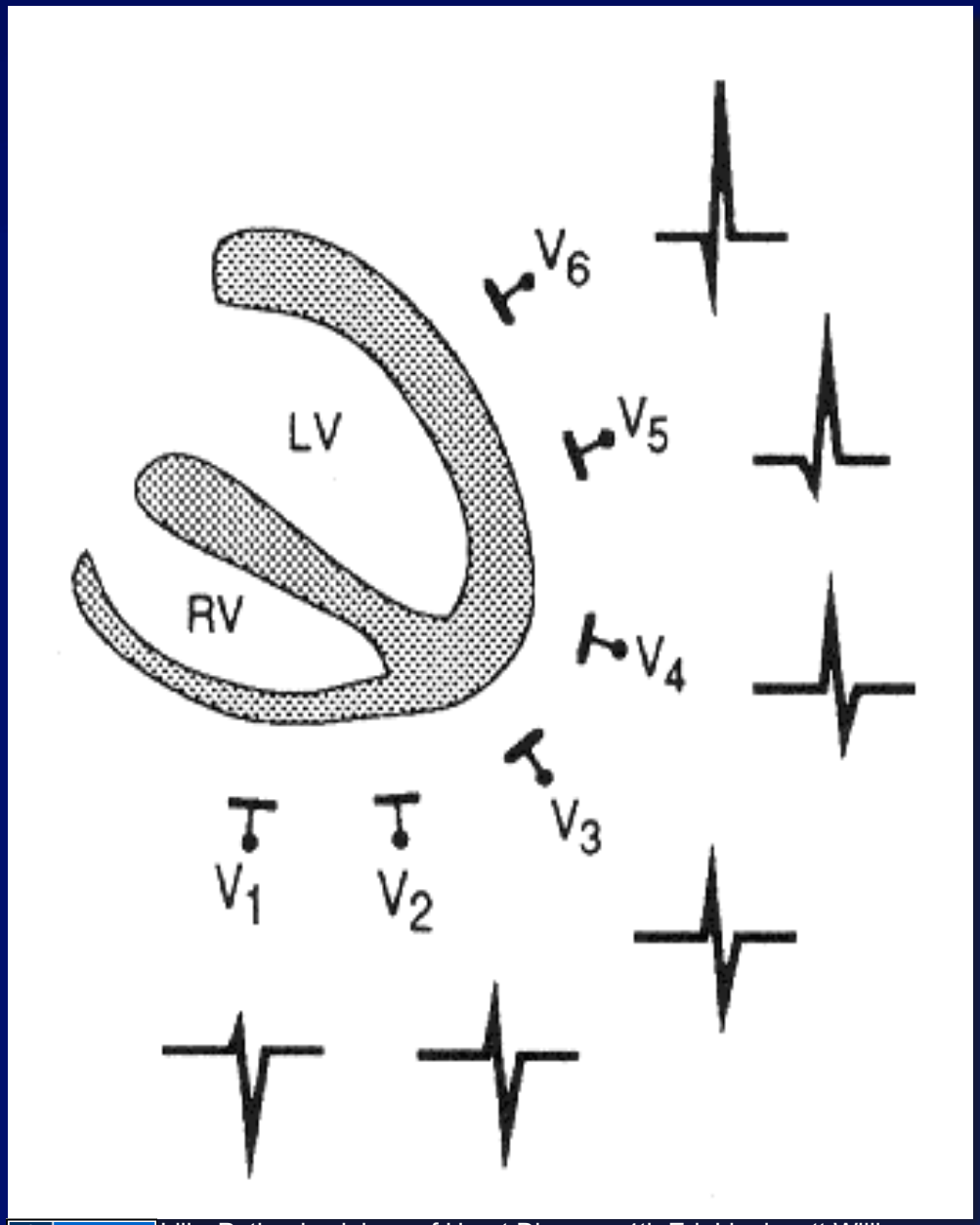

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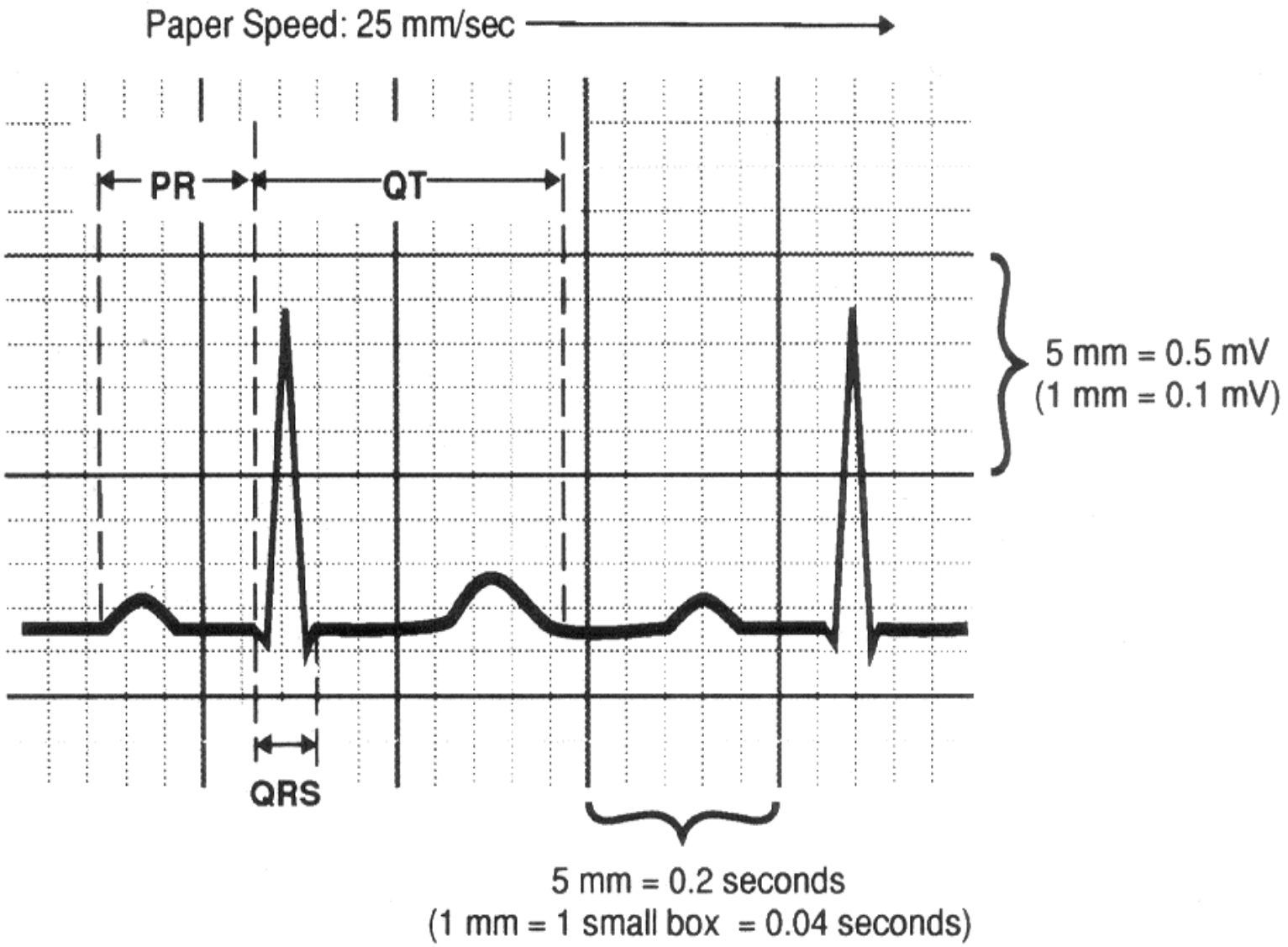
EKG Interpretation: 8 Steps

1. Check voltage calibration
2. Heart rhythm
3. Heart rate
4. Intervals (PR, QRS, ST)
5. Mean QRS axis
6. Abnormalities of P-waves
7. Abnormalities of QRS (hypertrophy, bundle branch block, infarction)
8. ST and T wave abnormalities



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Heart Rhythm

- Sinus Rhythm
- Rate $\geq$ 60 BPM

  $\leq$ 100 BPM

Method 1

The standard paper speed = 25 mm/sec. So, count the number of mm between two QRS complexes (i.e., between 2 "beats"). Then:

$$\textbf{Heart Rate (beats/min)} = \frac{(25\ \text{mm/sec} \times 60\ \text{sec/min})}{\text{number of mm between beats}} = \frac{1500}{\text{mm/beats}}$$

On this strip for example, there are 23 mm between the first 2 beats:

$$\text{Therefore, the heart rate} = \frac{1500}{23} = 65\ \text{beats/min}$$

Method 1 is particularly helpful for measuring fast heart rates (>100 bpm).

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Method 2

The "count-off" method requires memorizing the sequence:

300 - 150 - 100 - 75 - 60 - 50

In the example, count-off the number of large boxes between two consecutive beats:

The second QRS falls between the "75" and "60" beats/min; therefore the heart rate is approximately mid-way between them, ≈ 67 beats/min. Knowing that the heart rate is *approximately* 60-70 beats/min is certainly close enough.

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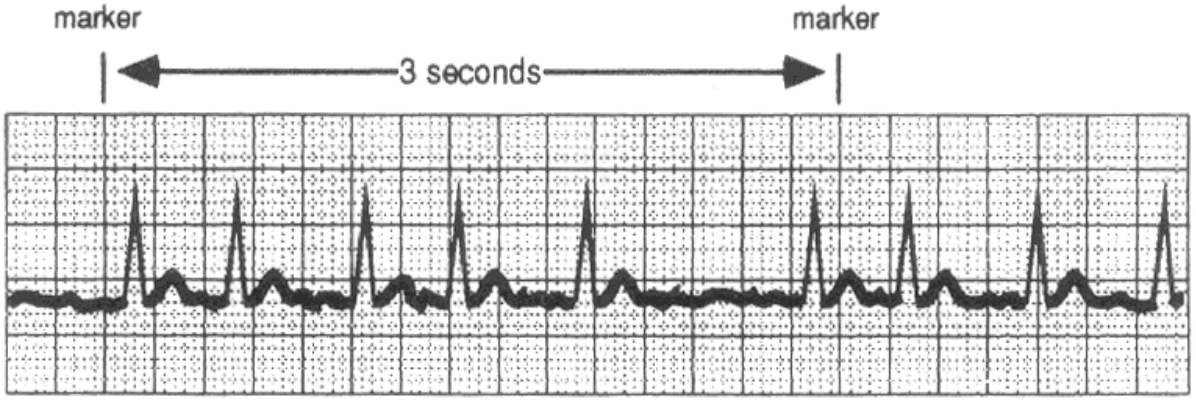
Method 3

EKG recording paper usually includes 3-second time markers at the top or bottom of the tracing:



To calculate the heart rate, count the number of QRS complexes between the 3 second markers (= 6 beats in this example) and multiply by 20. Thus the heart rate here ≈ 120 beats/min.

It's even easier (and a bit more accurate) to count the number of complexes between the first and *third* markers on a strip (representing 6 seconds) and then multiply by 10 to determine the heart rate.

Method 3 is particularly helpful for measuring irregular heart rates.

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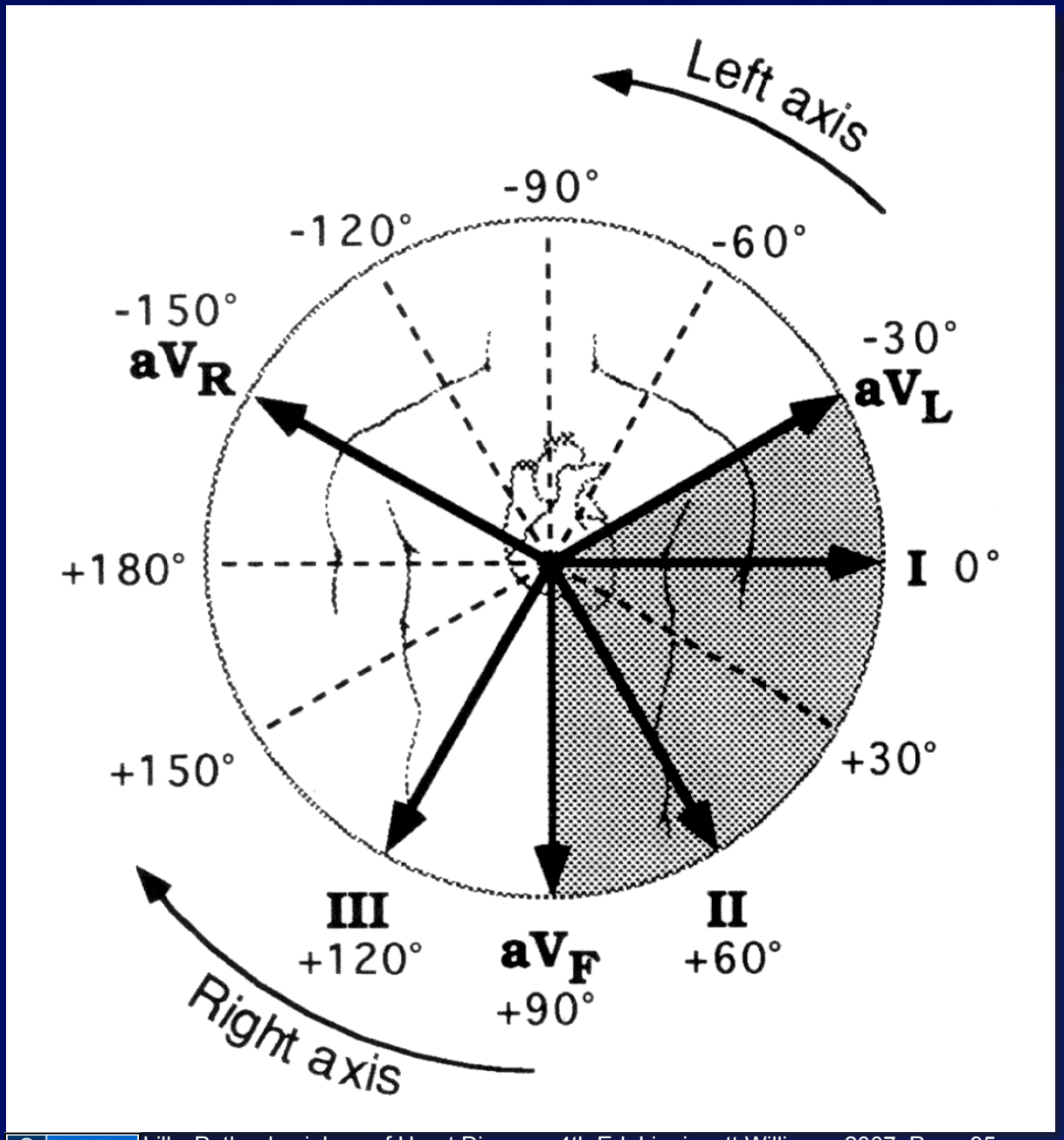
Electrocardiographic Intervals

Interval	Normal	Decreased in	Increased in
PR	0.12-0.20 sec (3-5 small boxes)	• Pre excitation syndrome • Junctional rhythm	• First-degree AV block
QRS	≤ 0.10 sec (≤ 2.5 small boxes)		• Bundle branch blocks • Ventricular ectopic beat • Toxic drug effect (e.g., quinidine) • Severe hyperkalemia
QT	Corrected Qt[a] ≤ 0.44 sec	• Hypercalcemia • Tachycardia	• Hypocalcemia • Hypokalemia (↑ QU interval due to ↑ U wave) • Hypomagnesemia • Myocardial ischemia • Congenital prolongation of QT • Toxic drug-effect (e.g., quinidine)



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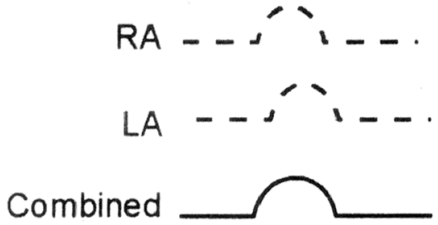
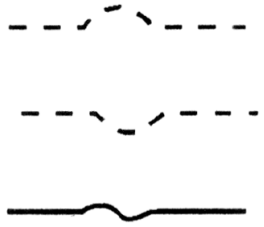
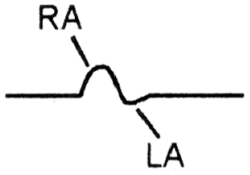
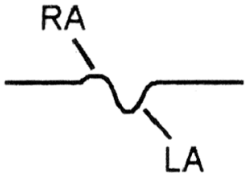
Atrial Abnormalities

	Lead II	Lead V_1
Normal		
RA enlargement		
LA enlargement		

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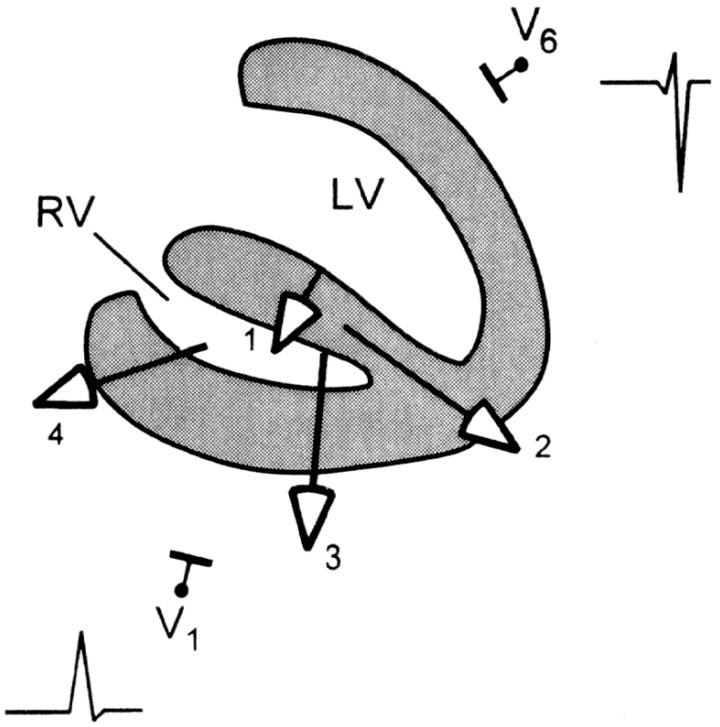
Ventricular Hypertrophy



RIGHT VENTRICULAR HYPERTROPHY
· R > S in lead V_1 · Right axis deviation

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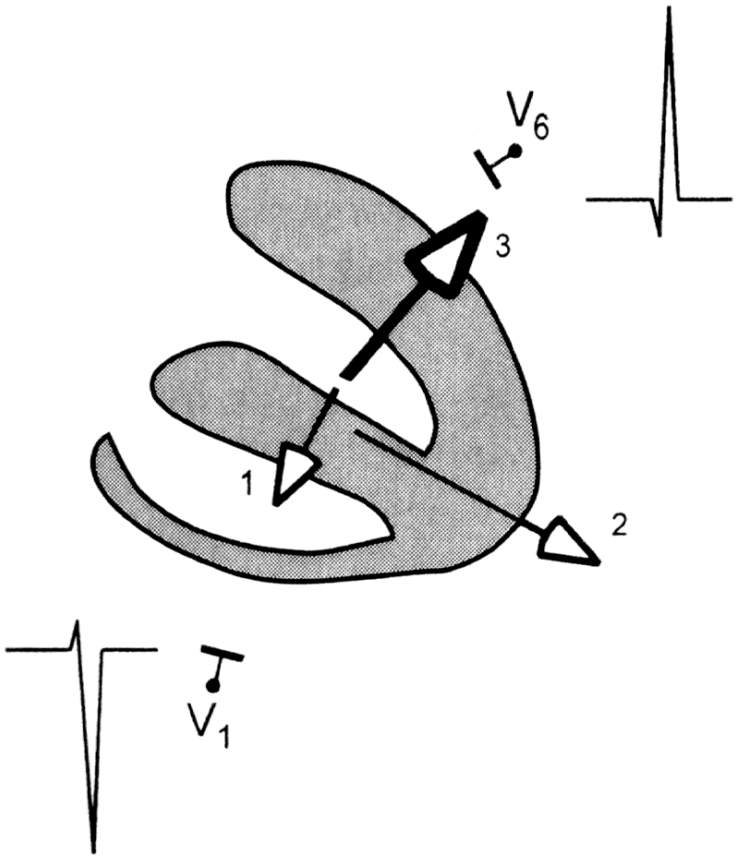
Ventricular Hypertrophy



LEFT VENTRICULAR HYPERTROPHY

- S in V_1 *plus*
  R in V_5 or $V_6 \geq 35$ mm *or*
- R in $aV_L > 11$ mm *or*
- R in Lead I > 15 mm

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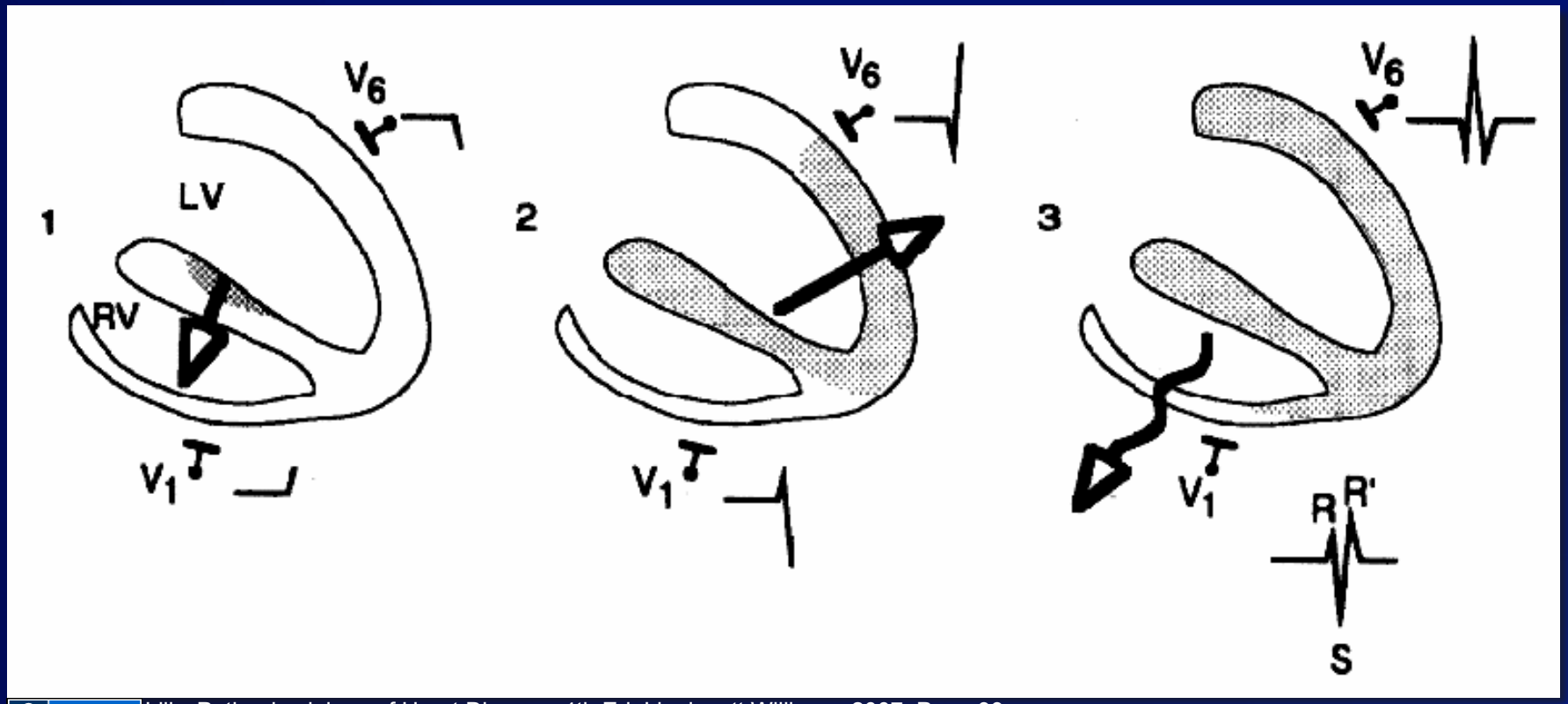
Bundle Branch Blocks

RBBB



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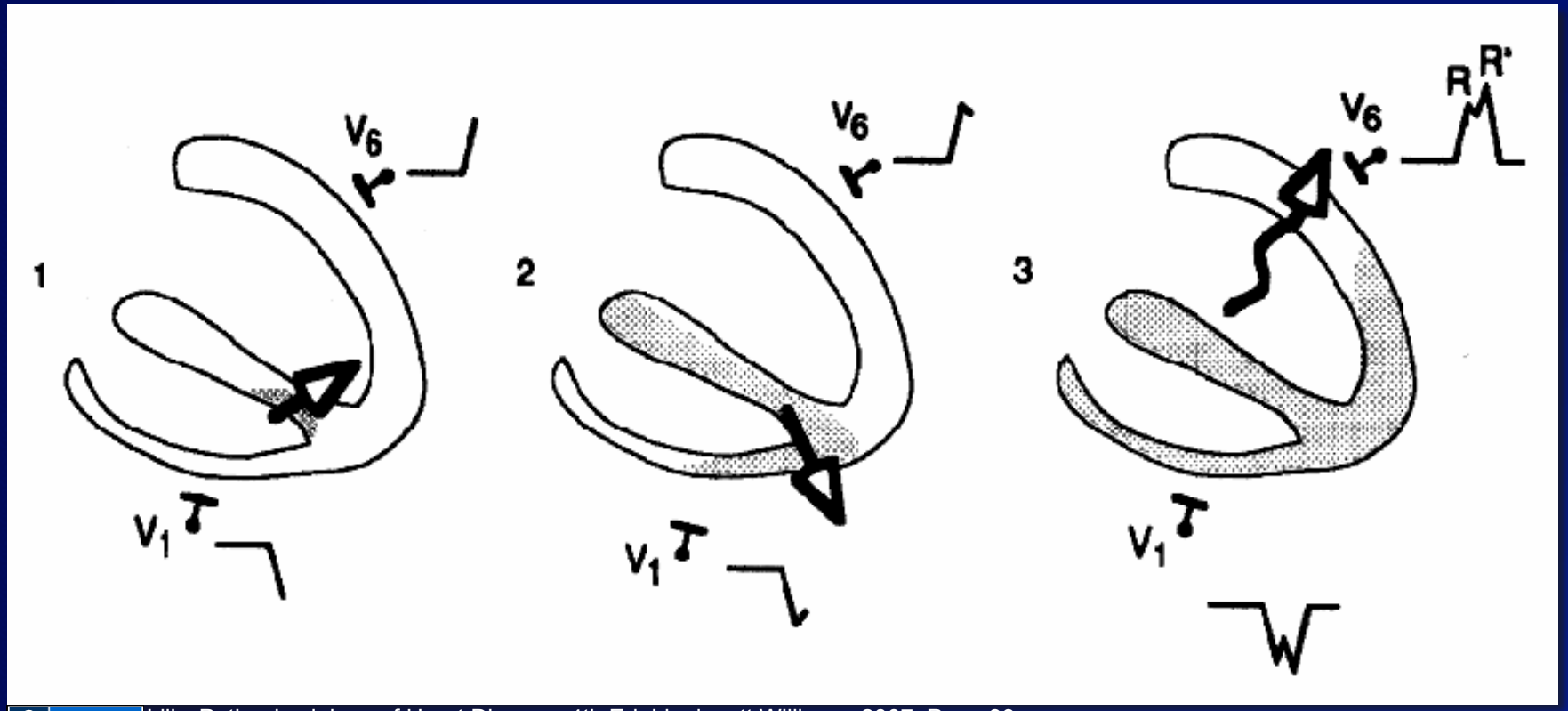
Bundle Branch Blocks

LBBB



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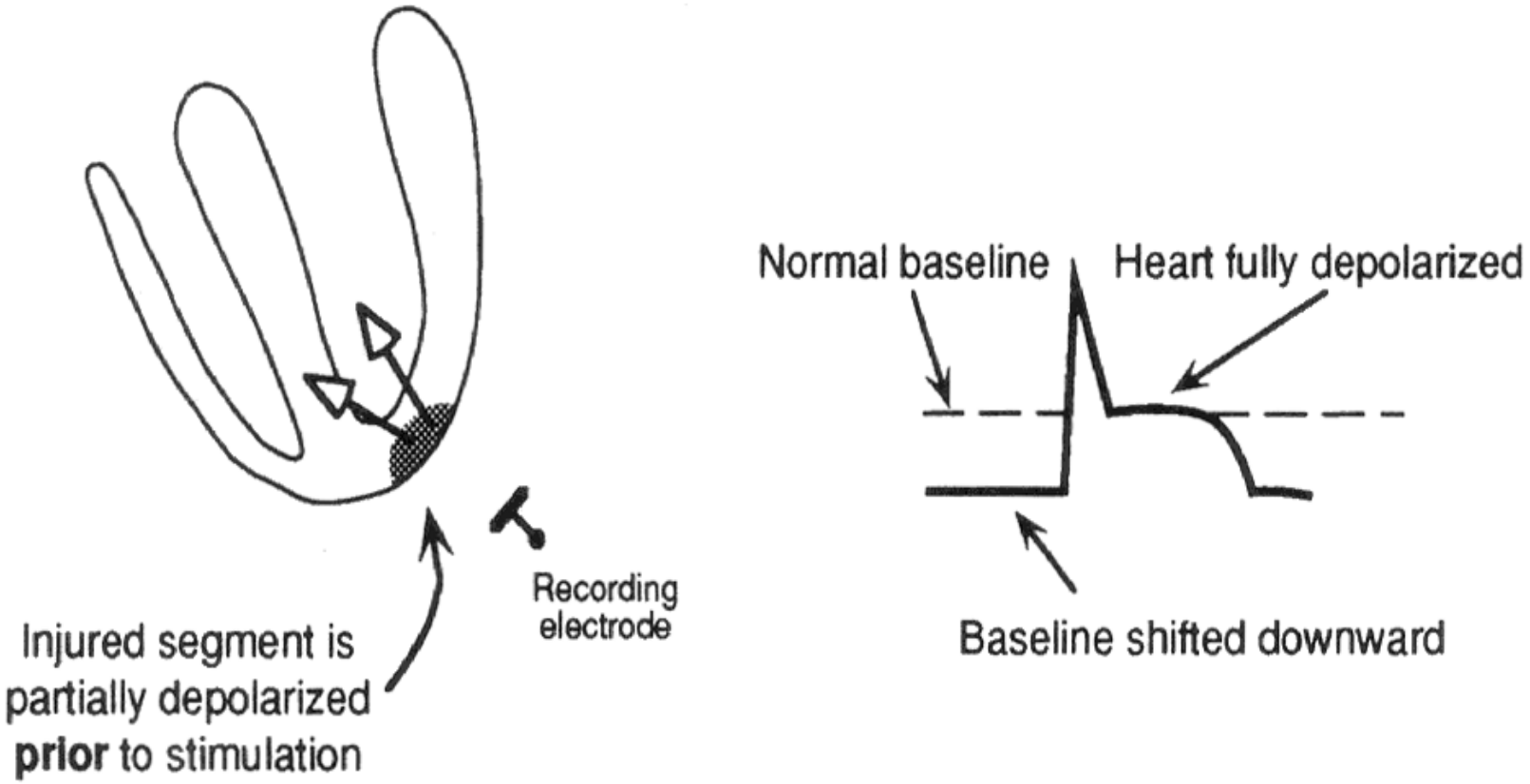
The EKG of Myocardial Infarction

- Concept of ST elevation vs. Non STE
- Localization of MI
- Evolution of EKG changes in MI
- Concept of Q waves

Transmural MI



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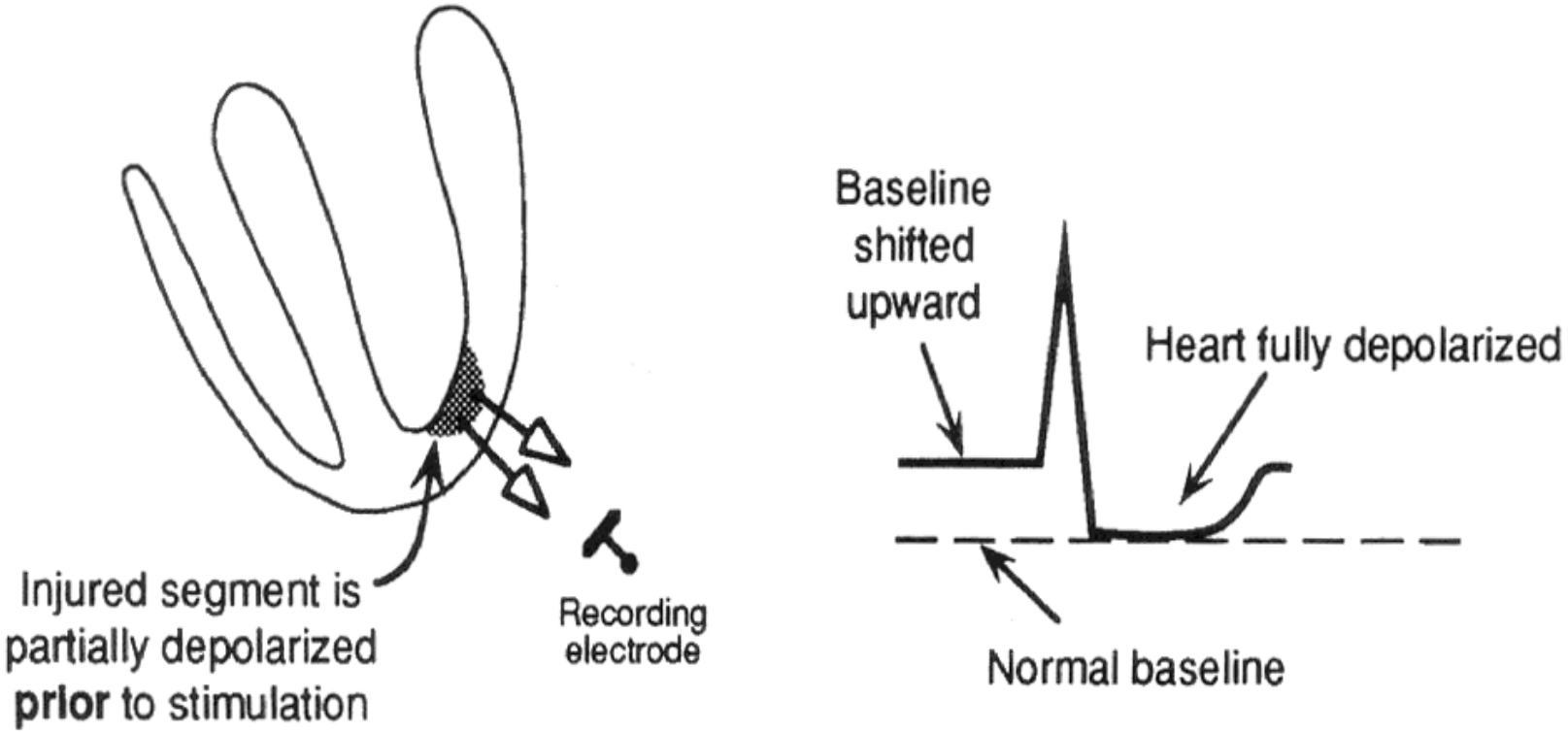
Non-transmural MI



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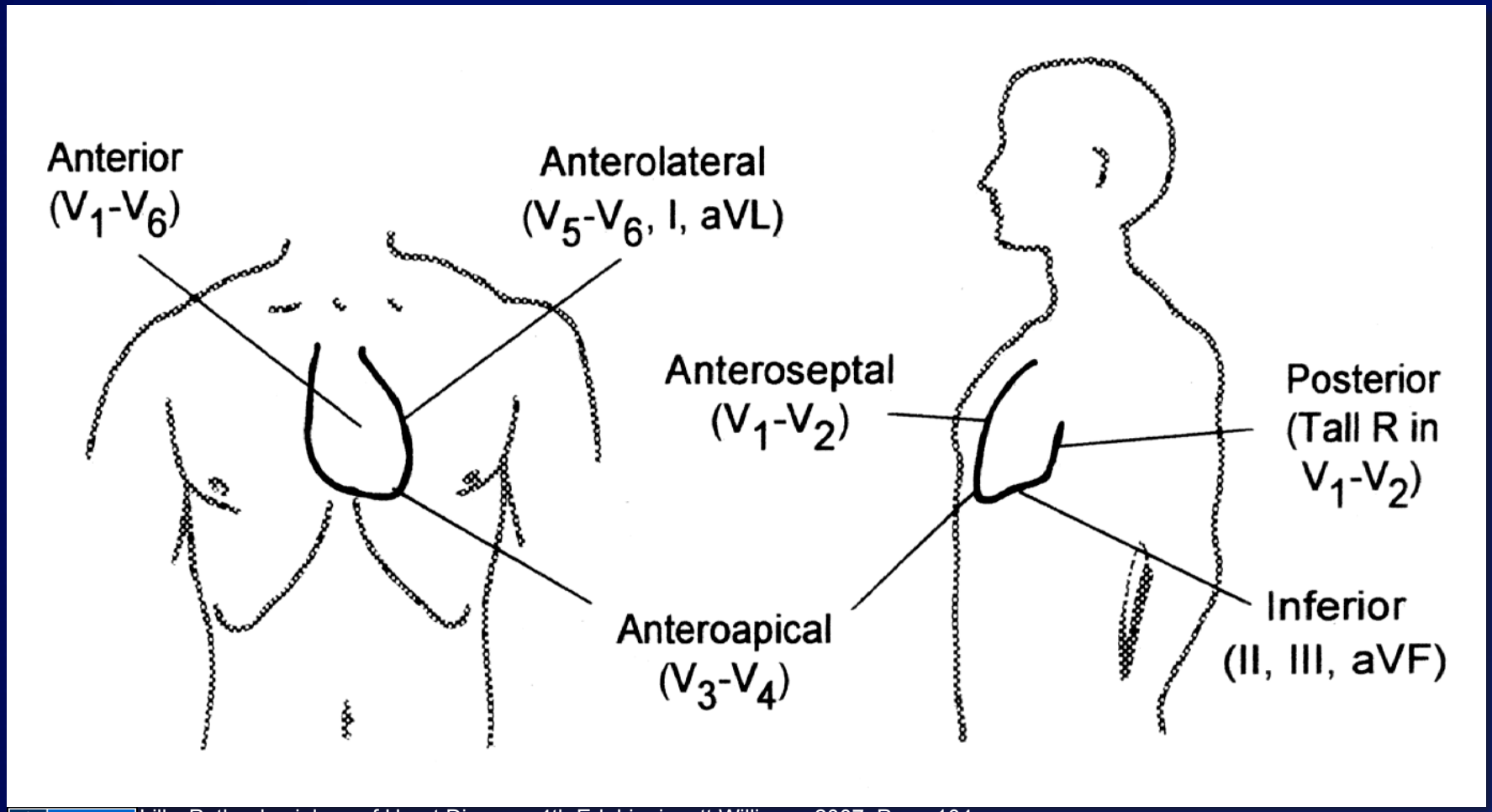
Localization of MI



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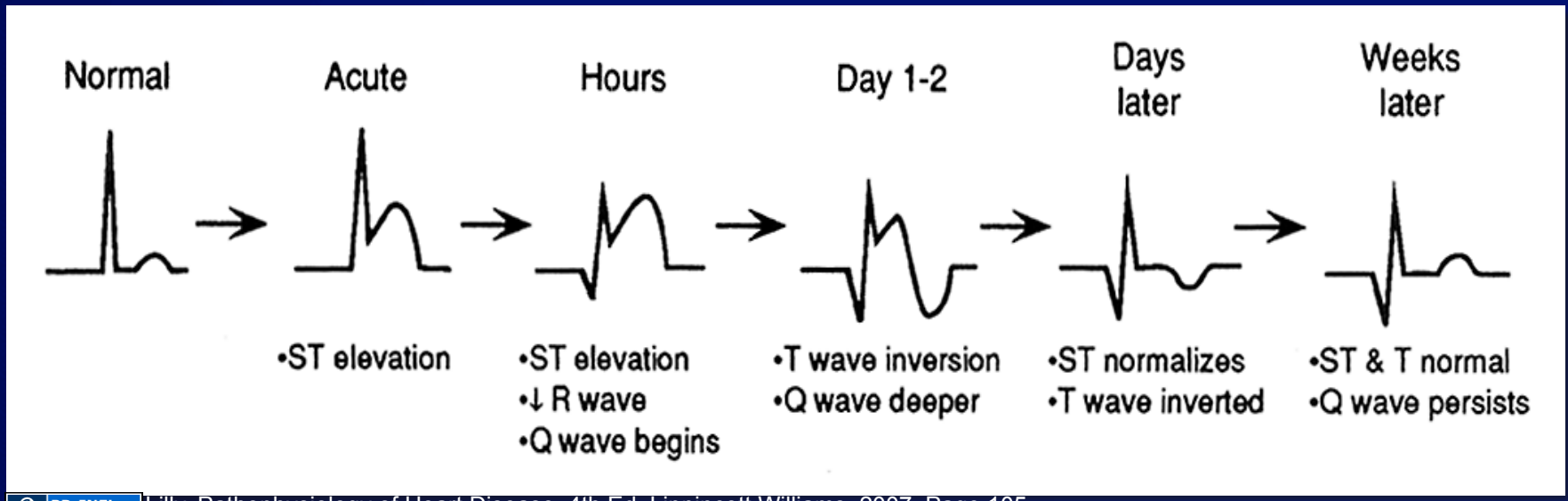
Localization of MI

Anatomic Sites	EKG Leads	Coronary Anatomy
Inferior	II, III, AVF	RCA
Septal	V_1, V_2	LAD
Anterior	V_3, V_4	LAD (distal)
Anterolateral	I, AVL	LCX
Anteroapical	V_5, V_6	Any of 3



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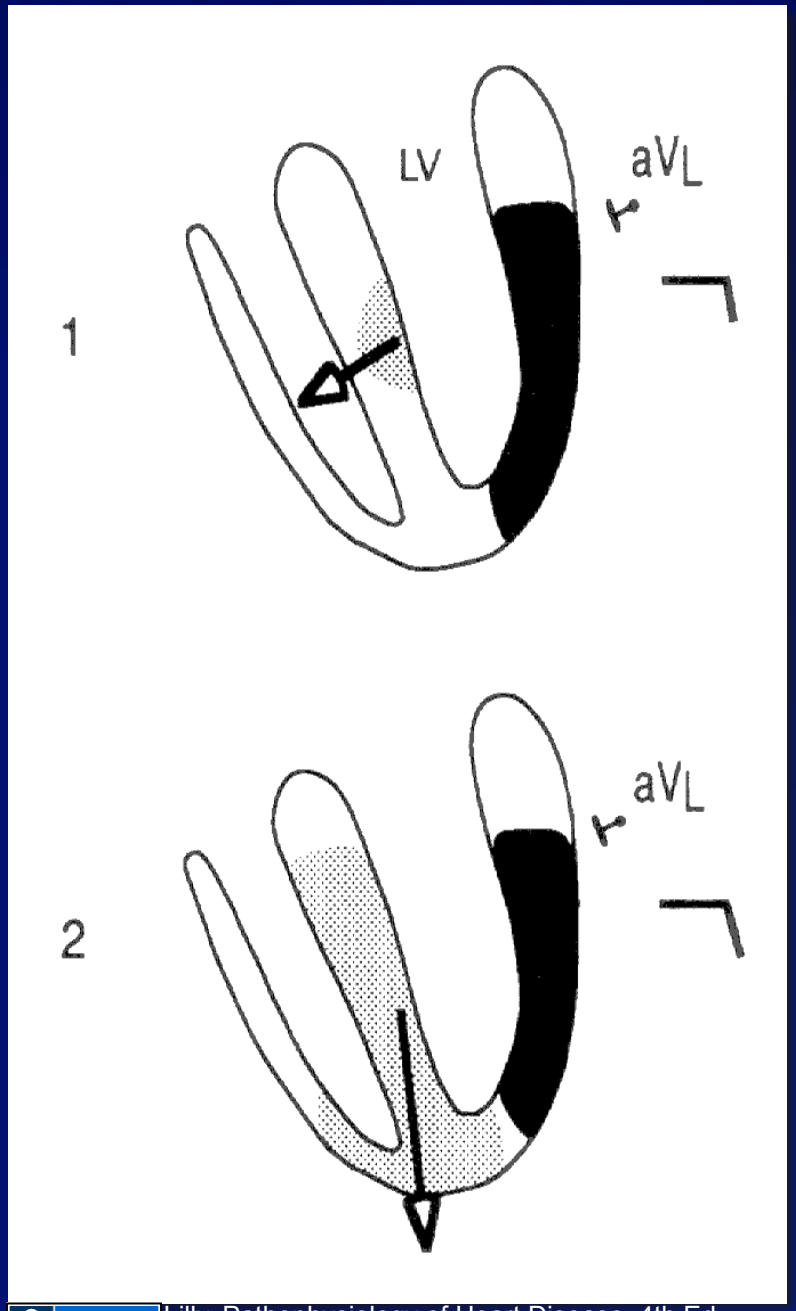

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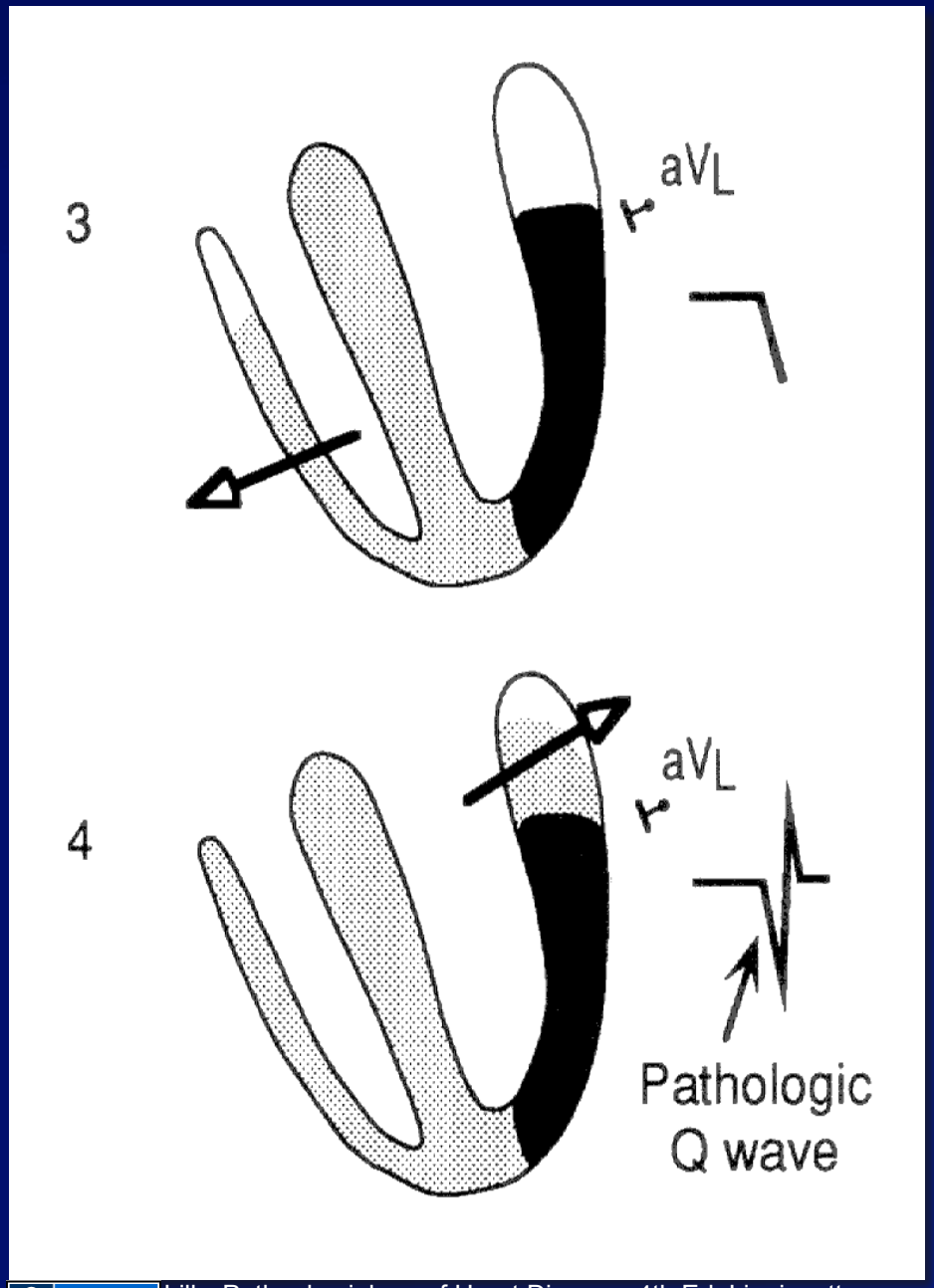

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