

Characteristics of epsilon or Fontaine wave in ARVC/D

"Fontaine discovered and named the epsilon waves. He chose the epsilon because it follows delta in the Greek alphabet and is the mathematical symbol for smallness" (Hurst 1998).

Intrinsic features: they are small notches or oscillations in variable quantities (1, 2, 3 or more).

Location: at the end of QRS in the J point or onset of ST segment (there is no consensus about this).

Leads: observed in right precordial leads; however Dr. Li Zhang et al, found the ϵ wave in the leads of the frontal plane, especially in inferior leads.

Frequency in ARVD: approximately 15-30% of cases in 12-lead ECG. This percentage increases if we use the ECG with the modified protocol.

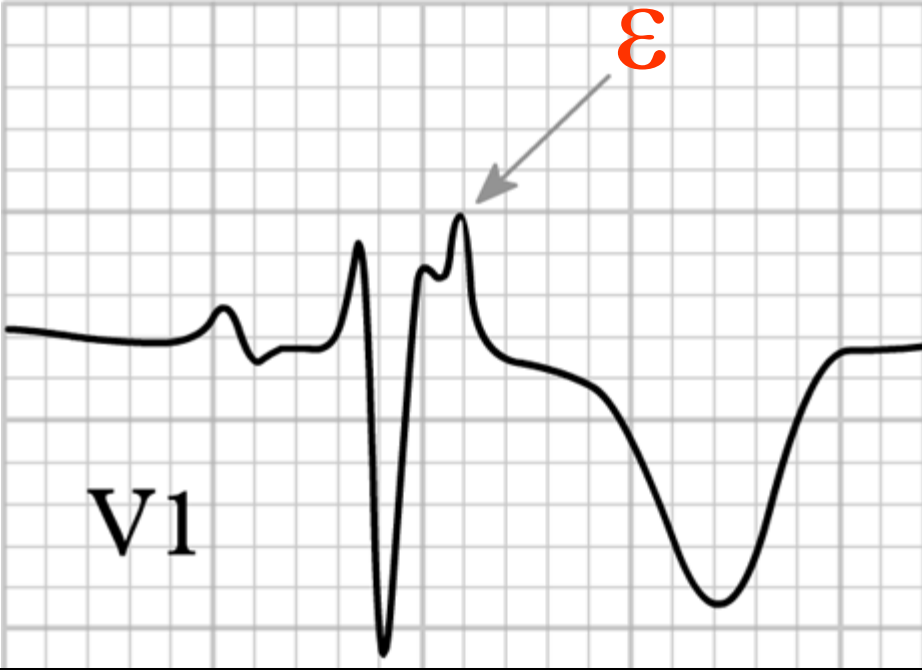
Value of criterion: considered to be a major criterion for diagnosis by the Task Force for ARVC/D diagnosis (McKenna 1994; Fontaine 1999).

High resolution ECG: observed more frequently with this method.

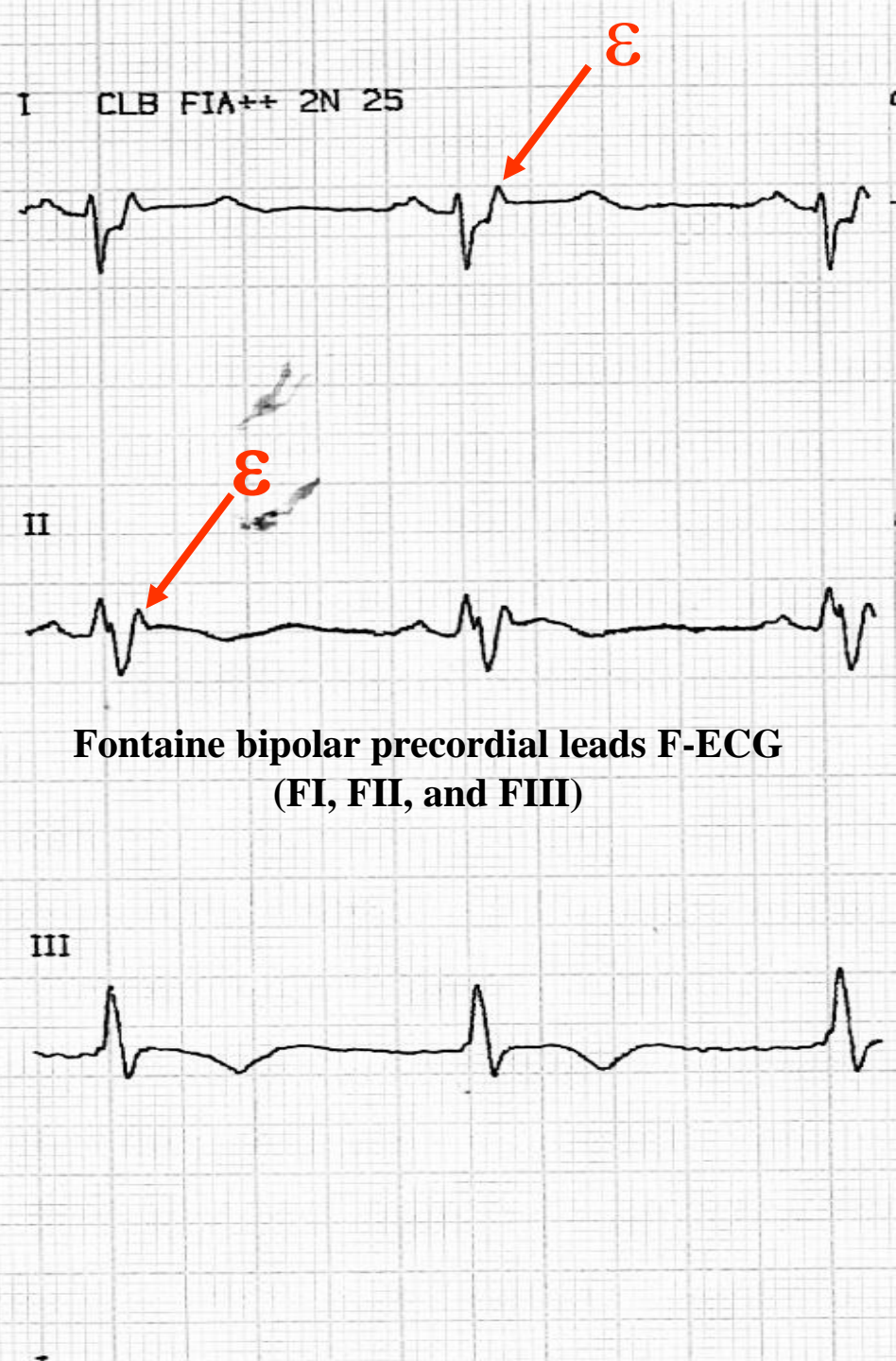
Pathognomonic character: in spite of the characteristics in ARVC/D, they are not pathognomonic, since they have been described in other diseases associated with myocardial damage: RV infarction, inferior or dorsal (Zorio 2005), sarcoidosis (Santucci 2004), sickle cell anemia (Hurst 1998), etc.

Meaning: late posterior potentials (PP) that occur in the RV free wall in patients with ARVC/D.

Inversion of T wave in leads V1-V3 and/or ϵ wave found in 70% of patients with ARVC/D. Epicardial electrophysiological studies in dysplastic areas reveal the LP that occur at the end of the QRS complex, in the J point, and at the onset of the ST segment, are explained by fibro-fatty substitution of myocardial tissue (Fontaine 1984).



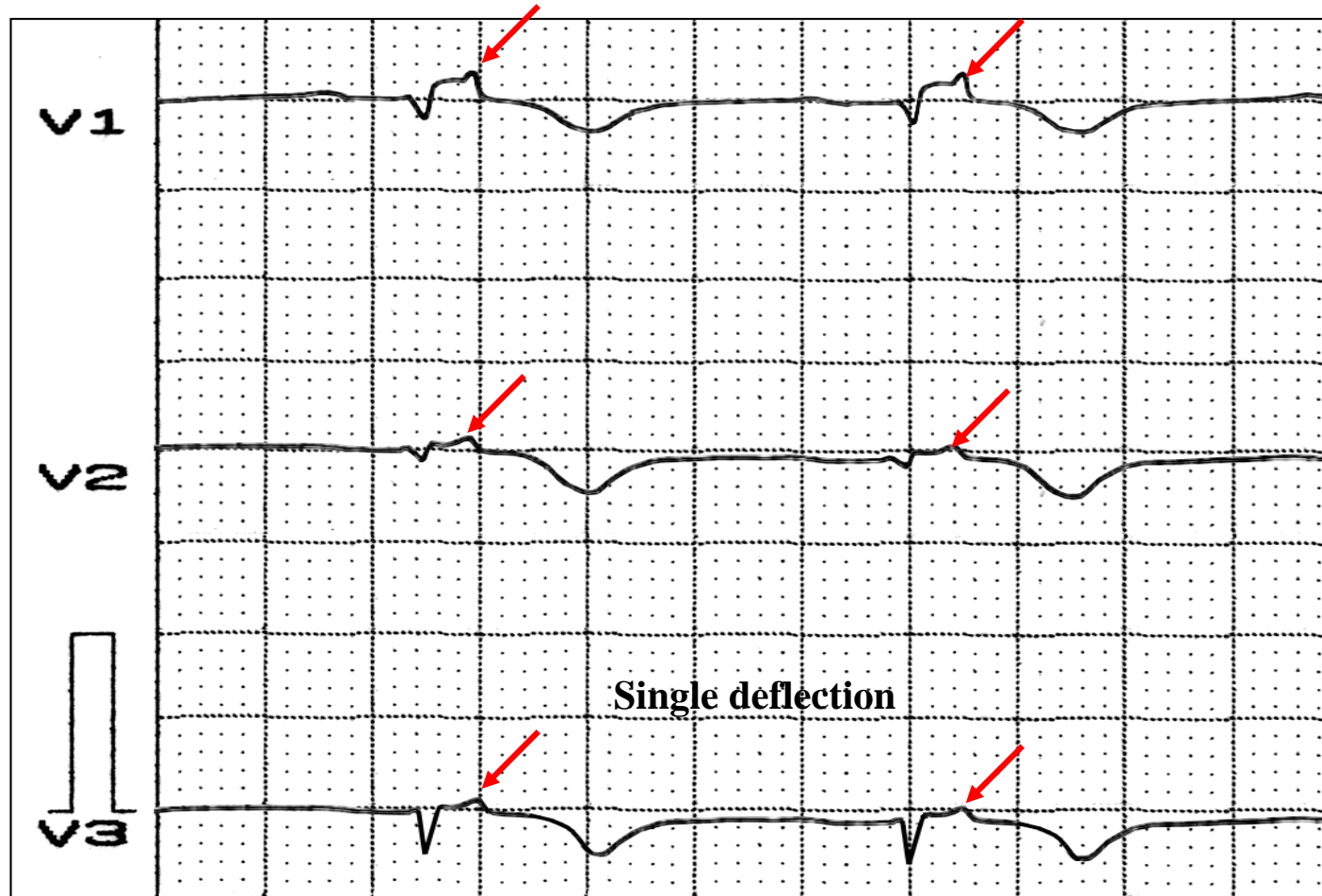
Source: ECGPEDIA.ORG



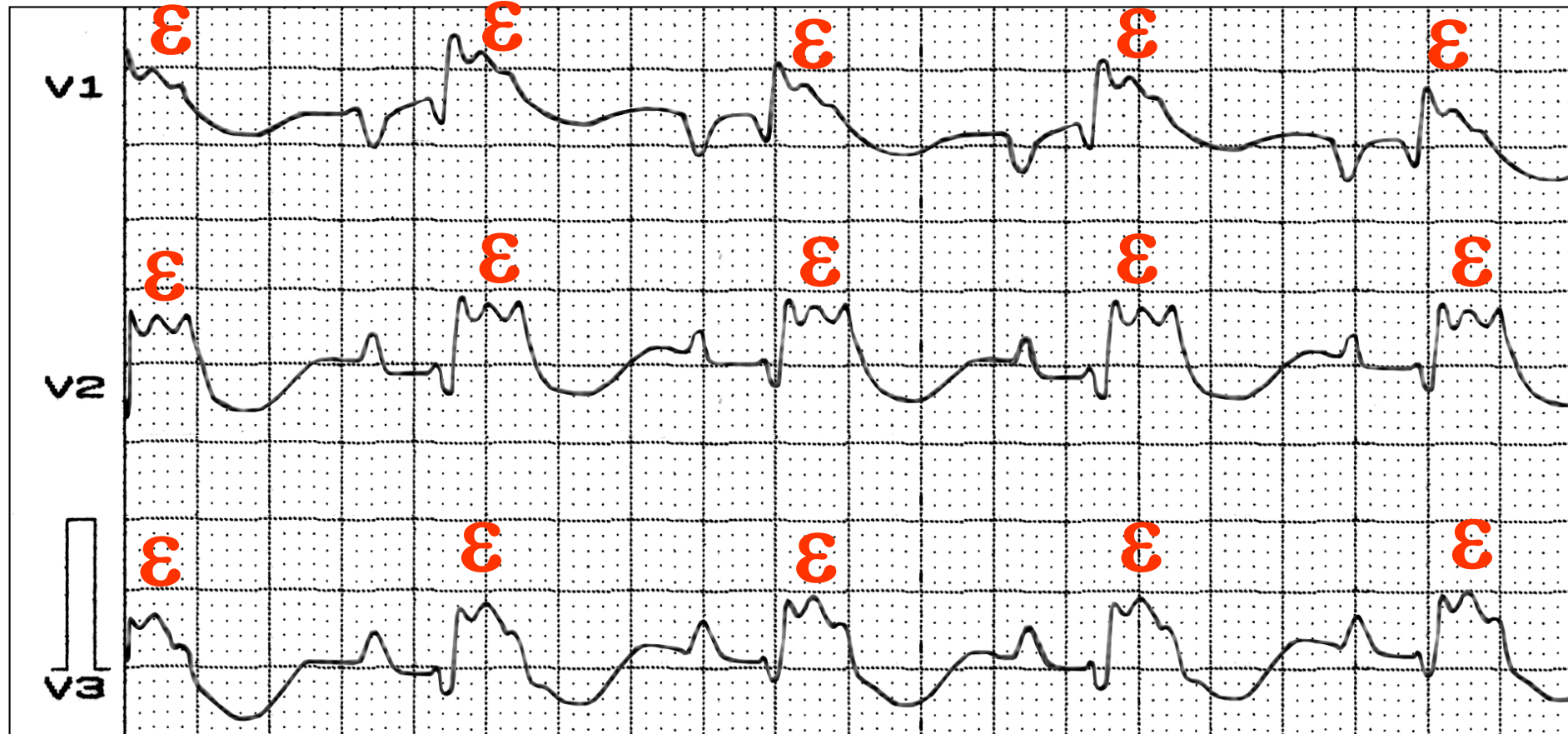
Characteristics of epsilon or Fontaine wave in ARVC/D

Epsilon wave and relationship to VT: the simple presence of these waves indicate slow and fragmented conduction, which favors reentry circuits, which in turn result in M-VT runs with CLBBB morphology by originating in the RV (Aldakar 1998; Sajejev 2004).

Morphological classification of epsilon wave

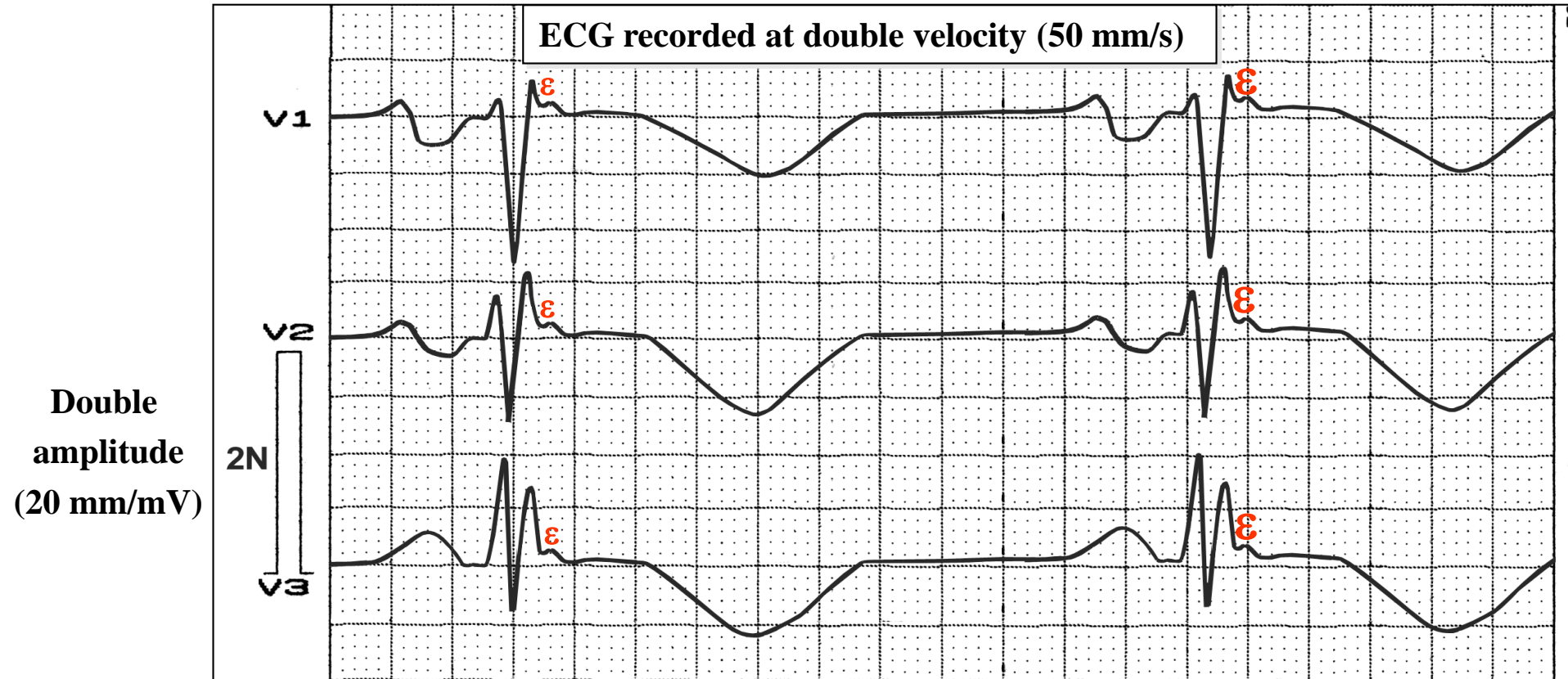


Epsilon wave with multiple deflections

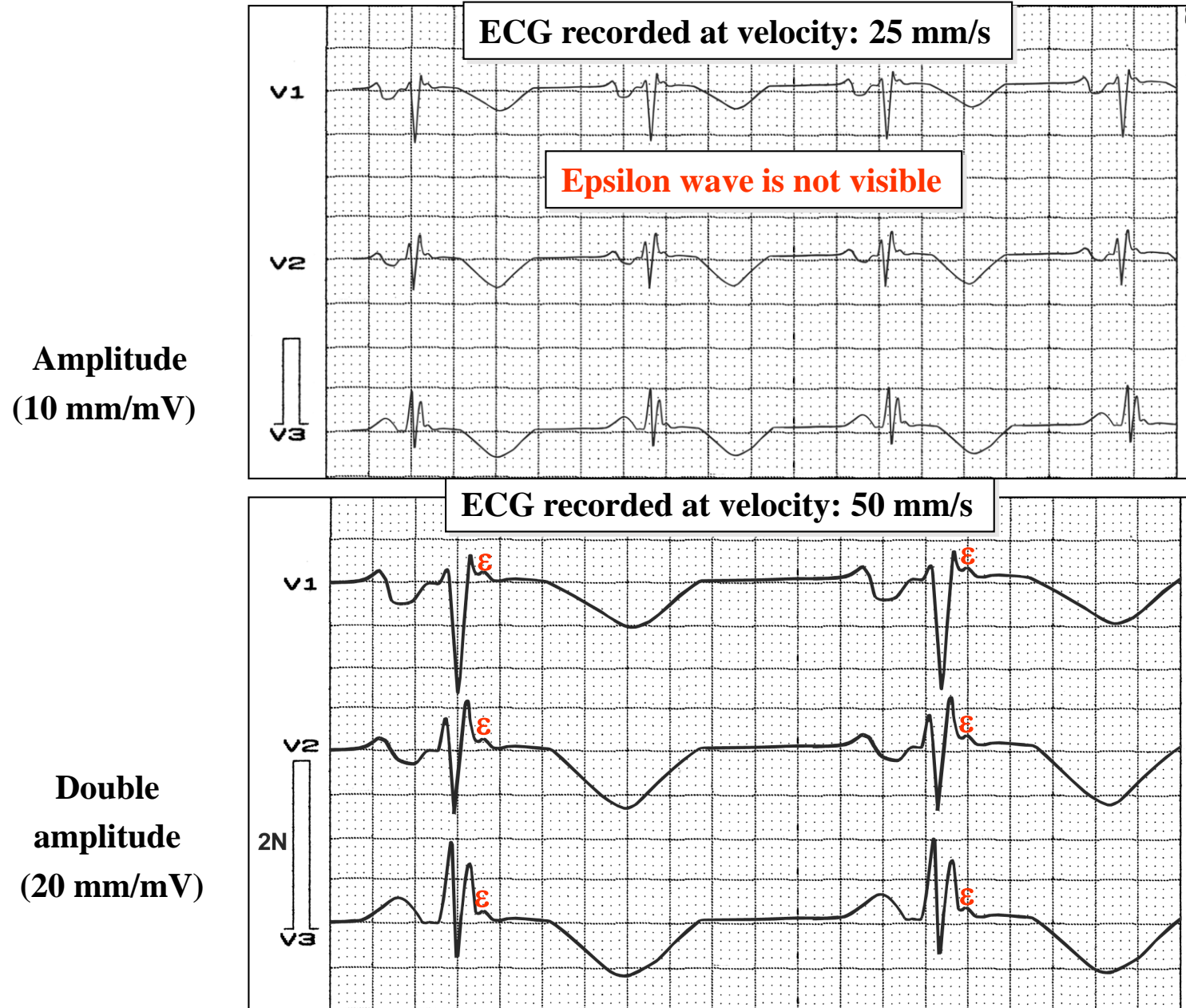


Epsilon wave characteristics in ARVC/D.

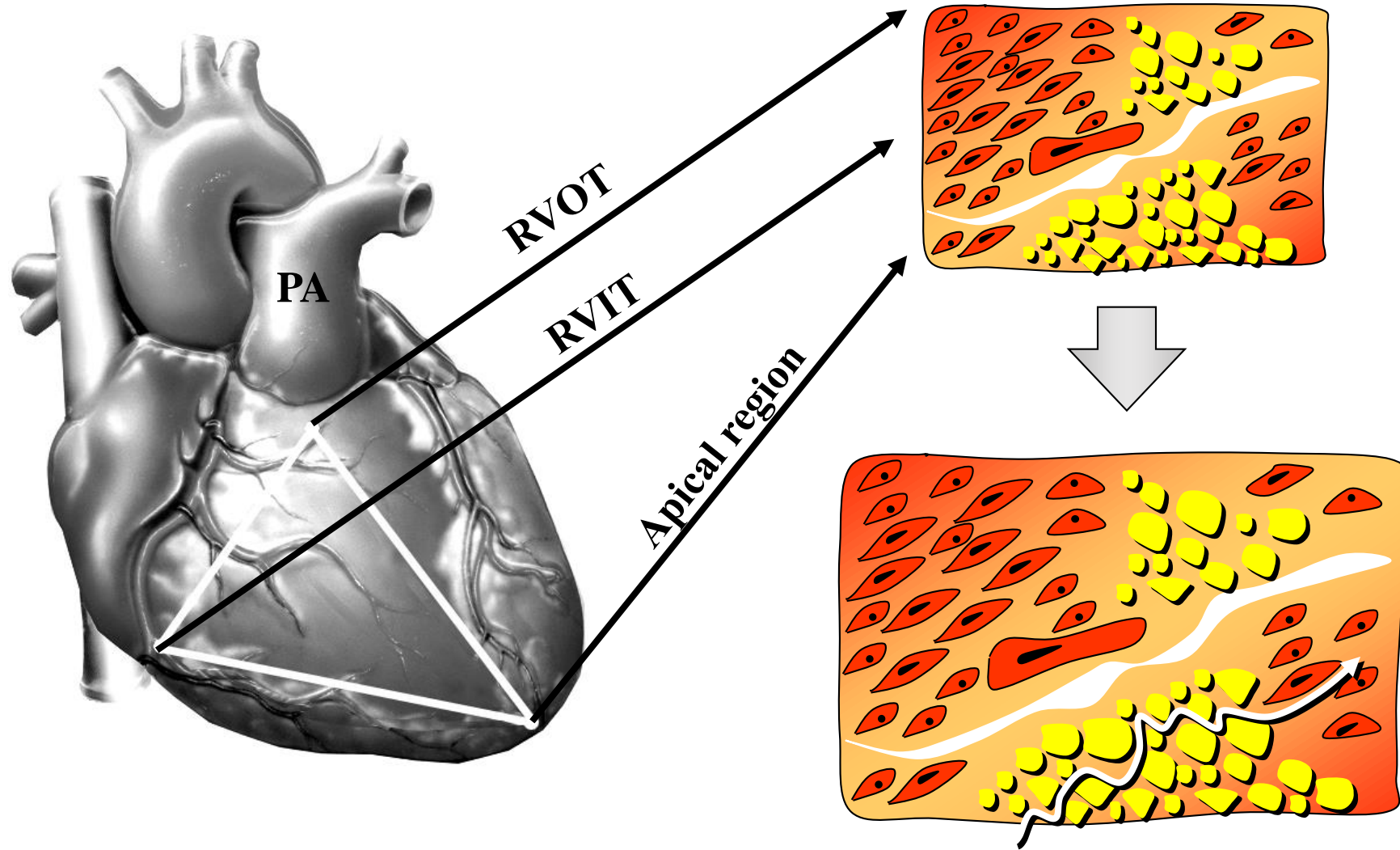
Epsilon wave (ϵ) characteristics in ARVC/D



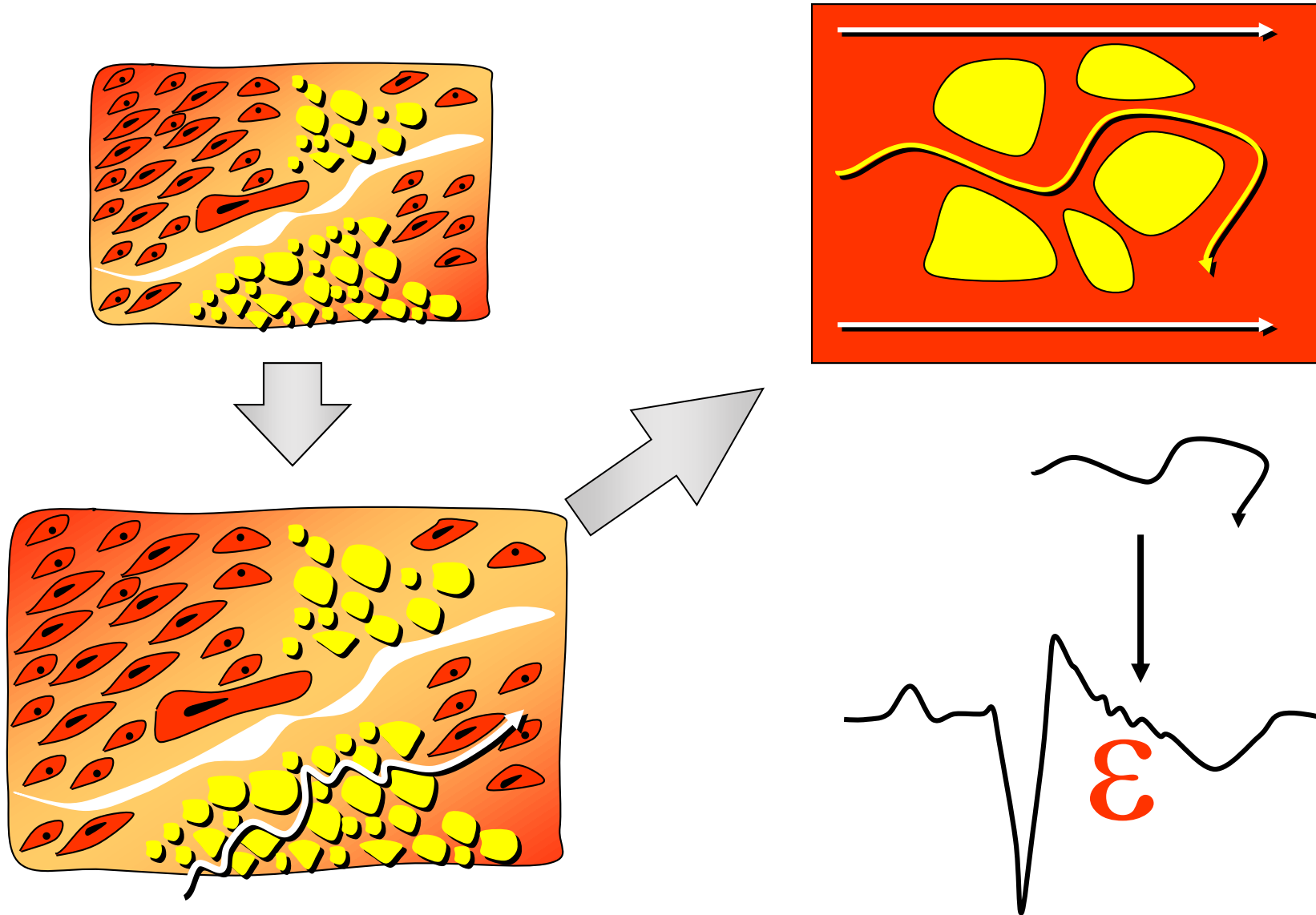
Epsilon wave (ϵ) characteristics in ARVC/D



Triangle of dysplasia in ARVD



Outline of Epsilon wave in ARVC/D



Modified protocol to obtain ECG in patients with suspicion of ARVC/D

The tracing should run at a double velocity (50 mm/s) and double voltage (20 mm/s) to compare the duration of QRS complexes (QRSd) in different leads, as well as to try to record Epsilon waves.

The Fontaine bipolar precordial leads

The tracing should be obtained from I and aVF at double velocity and amplitude, placing the electrode of the left arm on the xiphoid appendix, the one from the right arm on the manubrium sternum, and the one from the left leg on the rib at the fourth or fifth space with the aim of improving the ability to detect Epsilon waves.

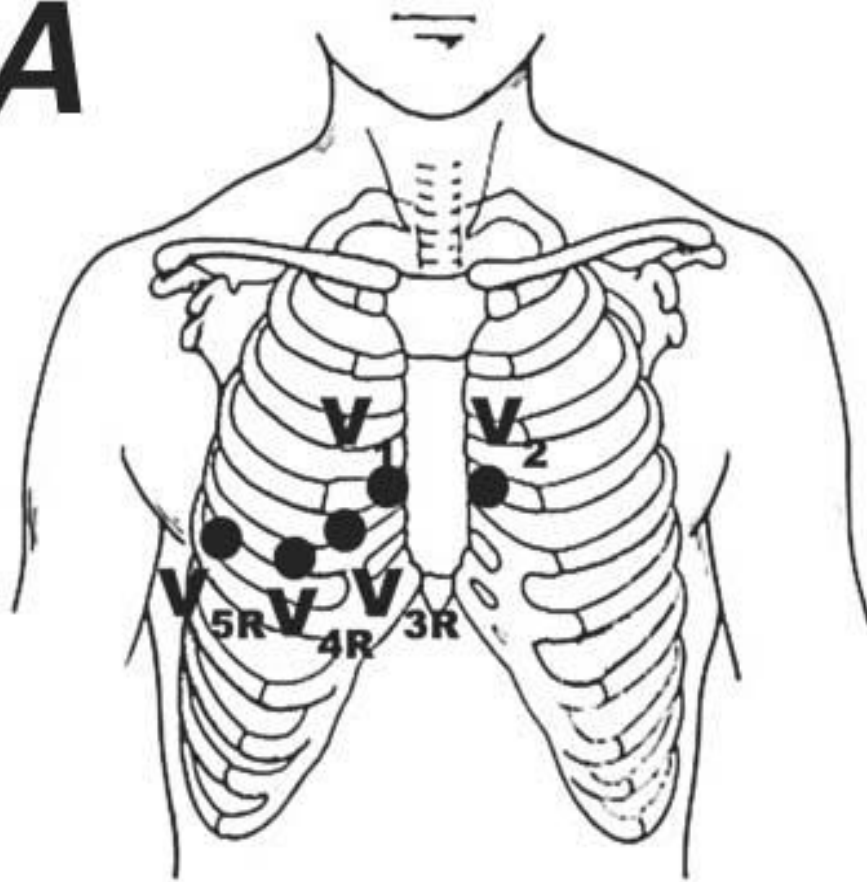
The Fontaine bipolar precordial leads are placed at the manubrium of sternum, xiphoid, and V4 positions using the right arm connection, left arm connection, and left foot connection, respectively.

Epsilon waves are detected by:

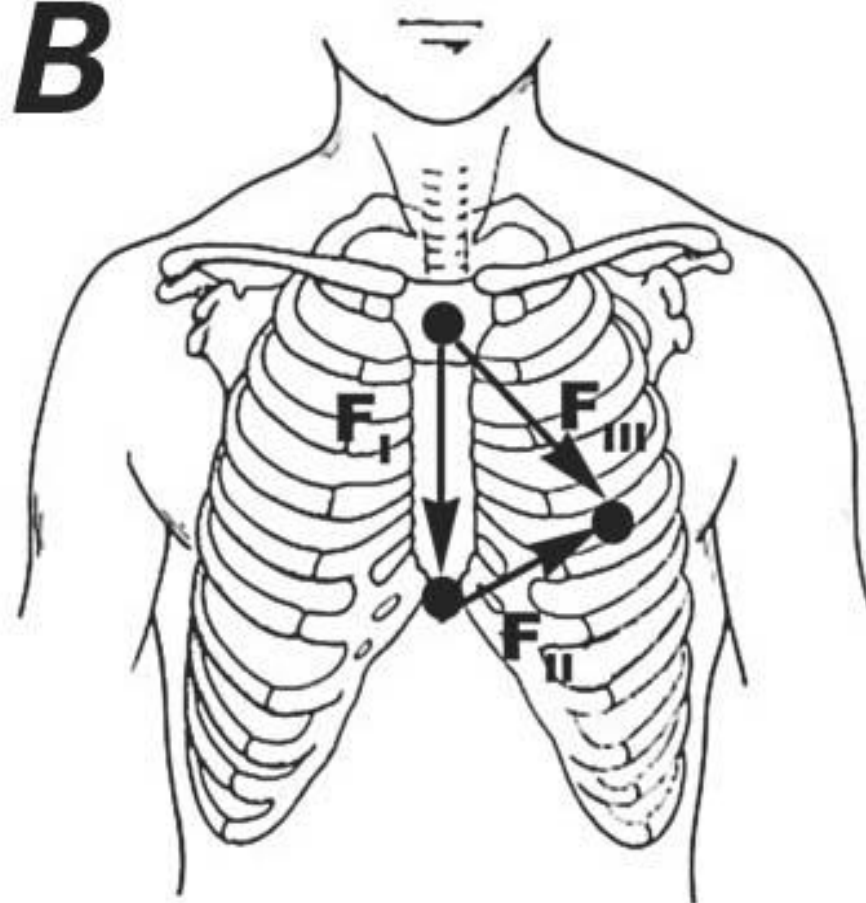
- Standard 12-lead electrocardiography (S-ECG)
- Right-sided precordial lead electrocardiography (R-ECG)
- Fontaine bipolar precordial lead electrocardiography (F-ECG).

The detection rate using combined methods is significantly higher than that by S-ECG alone.

Fontaine bipolar precordial leads have the best sensitivity among the three options. The placement of the foot lead (positive) in position V4 provides, instead of regular leads I, II, and III, three bipolar chest leads that can be called FI, FII, and FIII. Tracings are then produced by setting the machine on regular leads I, II, and III. This arrangement is used to record specifically the potentials developed in the RV, from the RVOT to the diaphragmatic area. The vertical bipolar lead FI, (similar to the aVF lead), seems to be the most appropriate to record epsilon waves; it also magnifies the atrial potentials. As late potentials were supposed to be the result of late activation of a limited group of fibers, the term "post-excitation" looked logical, since it was observed after the main excitation of the ventricle, leading to the QRS complex. The term "epsilon" was appropriate, because it occurs in the Greek alphabet after delta; thus, delta represents the preexcitation and epsilon the post-excitation phenomenon (Fontaine 1999).

A

Right precordial leads

B

The Fontaine bipolar precordial leads