How should we proceed to read the ECG in suspicion of LQTS? End of T wave and U wave diferentiation

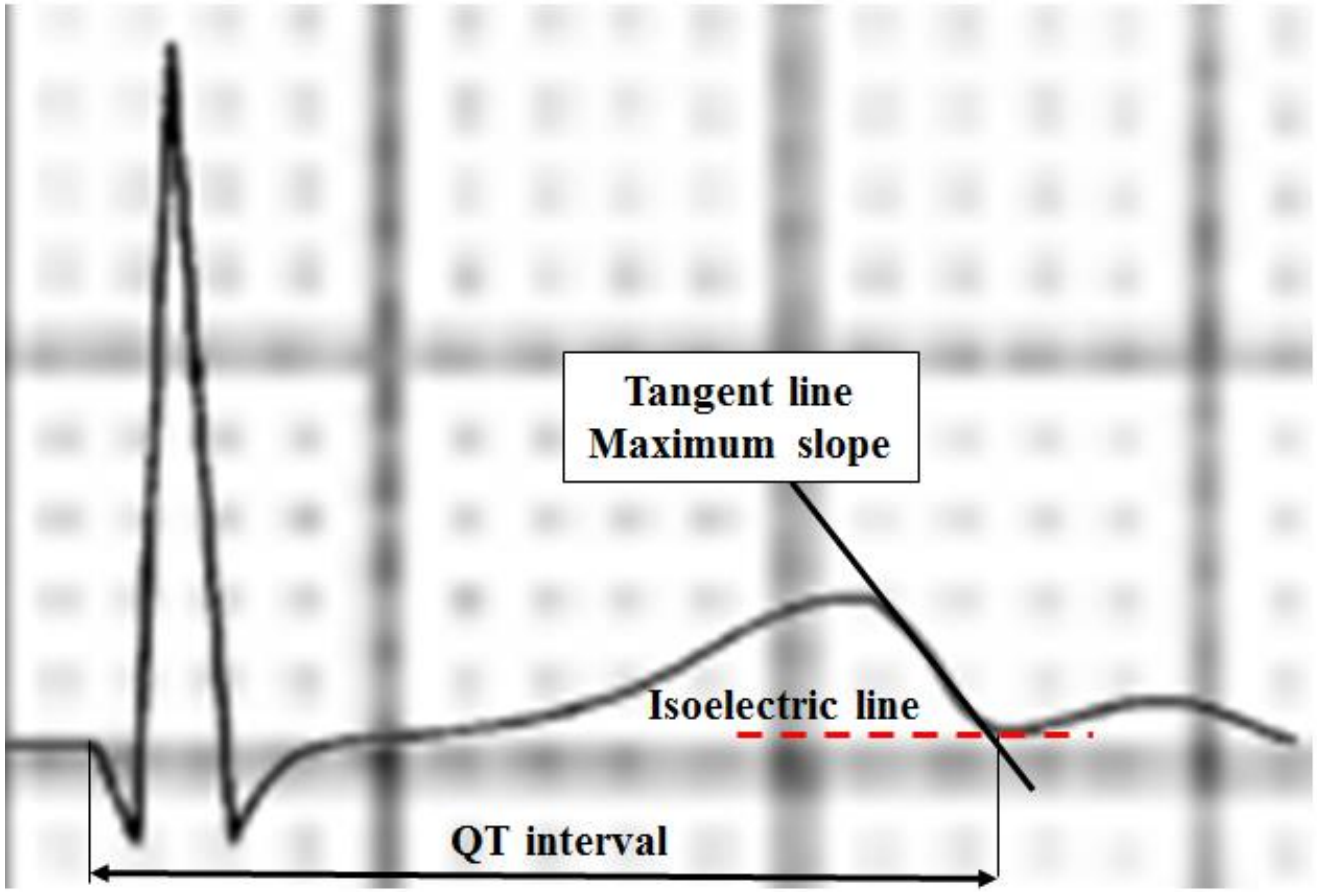
How should we proceed to read the ECG in suspicion of LQTS?

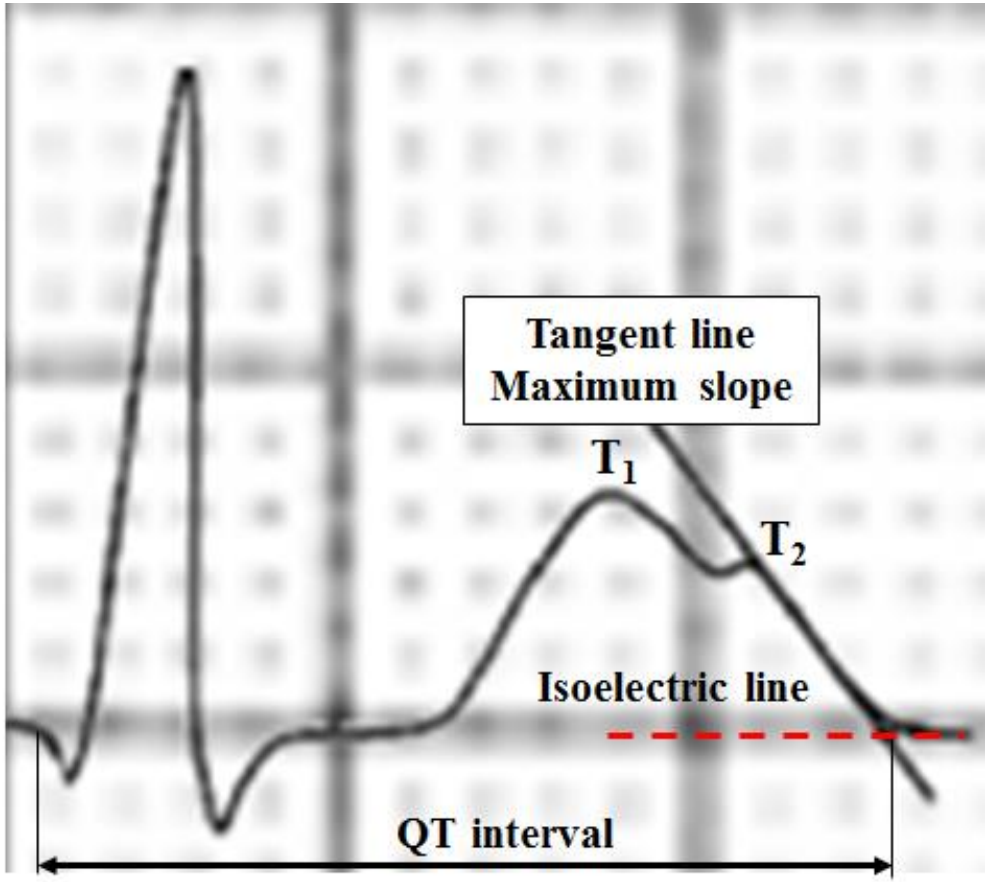
1. Do not perform the measurement of intervals and waves by the computerized method.
2. Conduct an independent review of ECG.
3. The measurement of the QT interval should be made by an experienced cardiologist.
4. The general cardiologist, before the suspicion of LQTS, should refer the patient to a colleague familiar with this for cardiological evaluation.

When measuring the QT interval, the ECG is best recorded at a paper speed of 50 mm/s and at an amplitude of 0.5 mV/cm using a multichannel recorder capable of simultaneously recording all 12 leads. A tangent line to the steepest part of the descending portion of the T wave is then drawn. The intercept between the tangent line and the isoelectric line is defined as the end of the T wave.(See next slide) The QT interval is measured from the beginning of the QRS complex to the end of the T wave on a standard ECG. There are no available data on which lead or leads to use for QT interval measurement. Traditionally, **lead II has been used for QT interval measurement** because in this lead, the vectors of repolarization usually result in a long single wave rather than discrete T and U waves.(Garson 1993) Generally, QT prolongation is considered when the QTc interval is greater than 440 ms (men) and 460 ms (women), although arrhythmias are most often associated with values of≥ 500. The severity of pro-arrhythmia at a given QT interval varies from drug to drug and from patient to patient. Unfortunately, the extent of QT prolongation and risk of TdP with a given drug may not be linearly related to the dose or plasma concentration of the drug because patient and metabolic factors are also important (for example, sex, electrolyte concentrations, etc). Furthermore, there is not a simple relation between the degree of drug induced QT prolongation and the likelihood of the development of TdP, which can occasionally occur without any substantial prolongation of the QT interval. The QT interval is influenced by HR. The RR interval preceding the QT interval should be measured for HR correction. Several formulae may be used to correct the QT interval for the biophysical effect of HR (QTc), but none is perfect. The most commonly used formulae are Fridericia's cube root formula (QTc = QT/RR1/3) and Bazett's square root formula (QTc = QT/RR1/2). Of the two, Bazett's formula is the more popular, but Fridericia's correction is preferred because it is more accurate at the extremes of physiological HR. Apart from HR, the duration of the QT interval is also subject to the techniques of recording and measurement error of the QT interval, sympathovagal activity, drugs, genetic abnormalities, electrolyte disorders, cardiac or metabolic diseases, changes of cardiac afterload, and diurnal variation which can be up to 75–100 ms. Definitions of normal QTc varies around being ≤400ms, 410ms (≤410ms), ≤420ms) or ≤440ms). For risk of SCD death "Borderline QTc" in males is 431-450 ms, and in females 451-470 ms. An "abnormal" QTc in males is a QTc >450 ms, and in females, > 470 ms. If there is not a very high or low HR, the upper limits of QT can roughly be estimated by taking QT=QTc at a HR of 60 bpm, and subtracting 20ms from QT for every 10bpm increase in HR. For example, taking normal QTc ≤ 420ms, QT would be expected to be ≤420ms at a HR of 60bpm. For a HR of 70 bpm, QT would roughly be expected to be equal to or below 400ms. Likewise, for 80 bpm, QT would roughly be expected to be ≤380ms

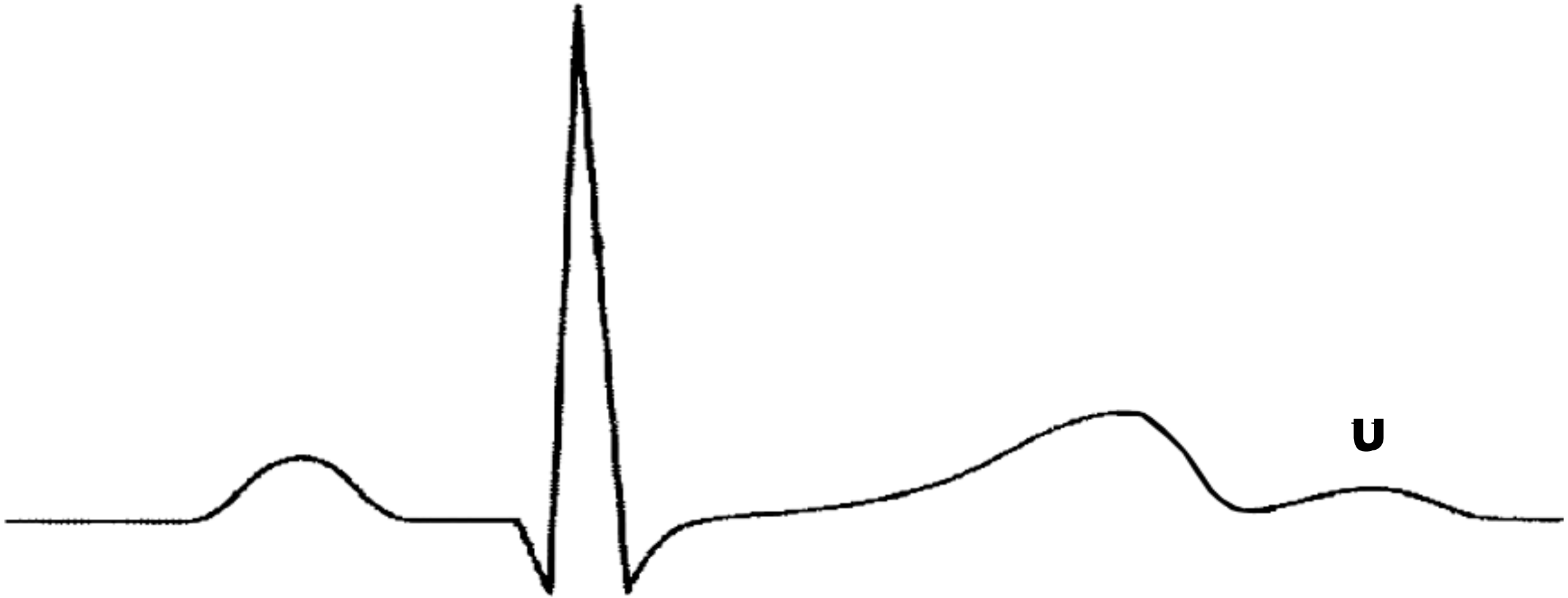
The end of T wave is determined by the maximum *slope intercept method*

The end of T is defined as the return of the T wave to the T-P baseline. The intercept between the tangent line and the isoelectric line is defined as the end of the T wave. The QT interval is measured from the beginning of the QRS complex to the end of the T wave on a standard ECG. There are no available data on which lead or leads to use for QT interval measurement. This method defines the en of T waves as the intercept between the isoelectric lines with the tangent drawn through the maximum downslope of the T wave. When the T wave is notched, the QT interval is measured form the beginning of the QRS complex extending to the intersection point between the isoelectric line and the tangent drawn from the maximum down slope of the second notch, T2. The second apex of bimodal T wave (T2) is at a distance <150 ms of the first module (T1). The T1-U interval is always >150 ms.



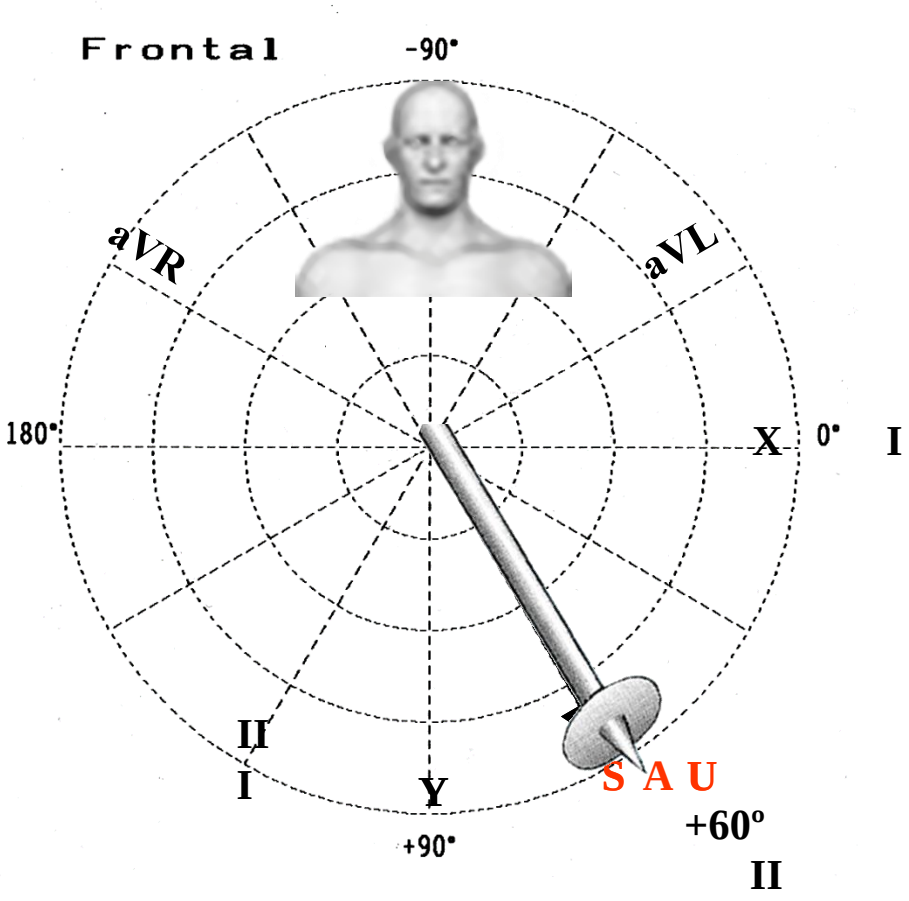


U-wave



Located immediately after the T wave during the protodiastolic phase of the cardiac cycle (diastolic isovolumetric phase and of fast filling) concomitant to the second noise and with phase 4 of action potential (AP); frequently absent; **occasionally hard to distinguish from the preceding T wave**; better observed during bradycardia and sometimes related to torsades de pointes (TdP). It is occasionally difficult to separate from the preceding

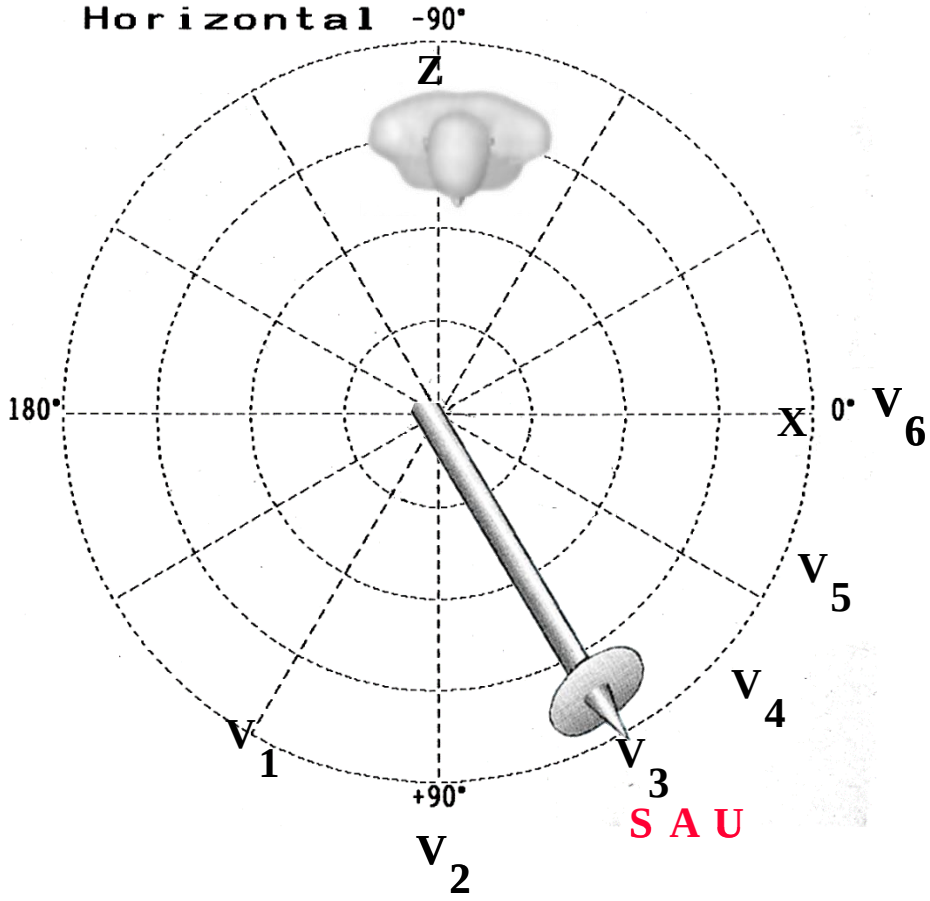
Electrical axis of U wave or SÂU in the Frontal Plane



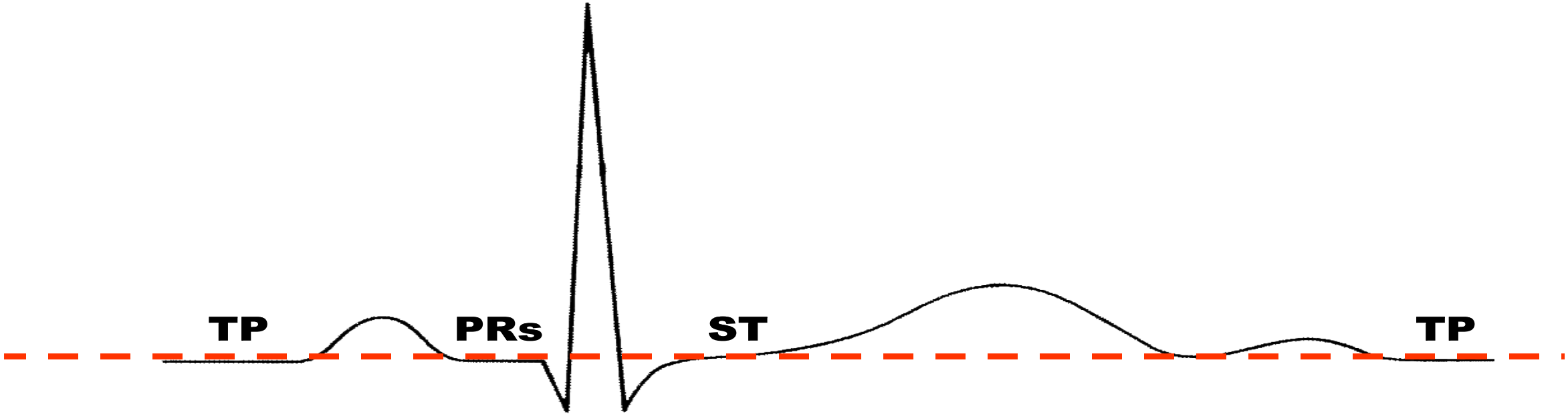
Normal SAU is around + 60. Thus, U wave is positive in II, III and aVF, and negative in aVR.

It shows the normal location of U wave axis (SAU) in the frontal plane.

Electrical axis of U wave or SÂU in the Horizontal Plane



SÂU points towards the left. Thus, U wave is better observed in V3 (between V2 and V4).
The U wave is better observed in precordial leads when compared to FP leads.



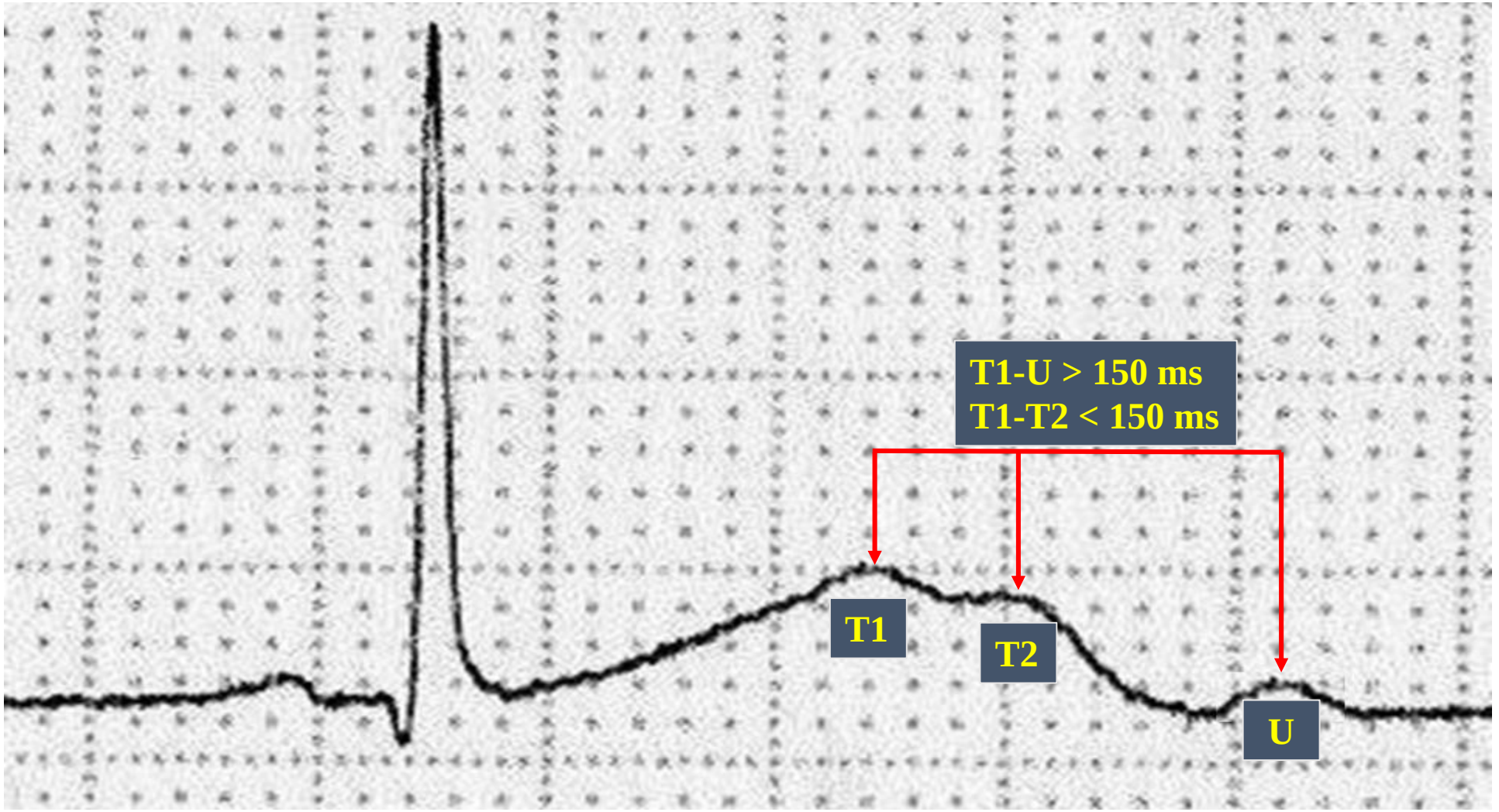
Usually, PR segment (end of P wave up to QRS complex onset), ST segment (from J point or the end of QRS up to the beginning of the T wave) and TP segment (from the end of the T wave up to the P wave of the following cycle) are at the same level. The figure shows a normal ECG and a line of dots pointing out the level of the three segments: PR, ST and TP. **PR (PRs) or PQ segment:** it stretches from the end of P wave to the onset of QRS complex. The PR segment is leveled when it is at the same level of the PR segment of the beat being studied. If the PR segment falls below the baseline (TP segment of precedent beat), then it is said to be depressed.

ST segment: it stretches from the J point (union of ST with the end of QRS complex) up to the onset of the T wave.

TP segment: it stretches from the end of T wave to the onset of the P wave of the next cycle. TP segment is between the end of the T wave and the beginning of the next P wave. It is the true isoelectric interval in the electrocardiogram. In other words the PR segment changes are relative to the baseline formed by the precedent TP segment of anterior beat.

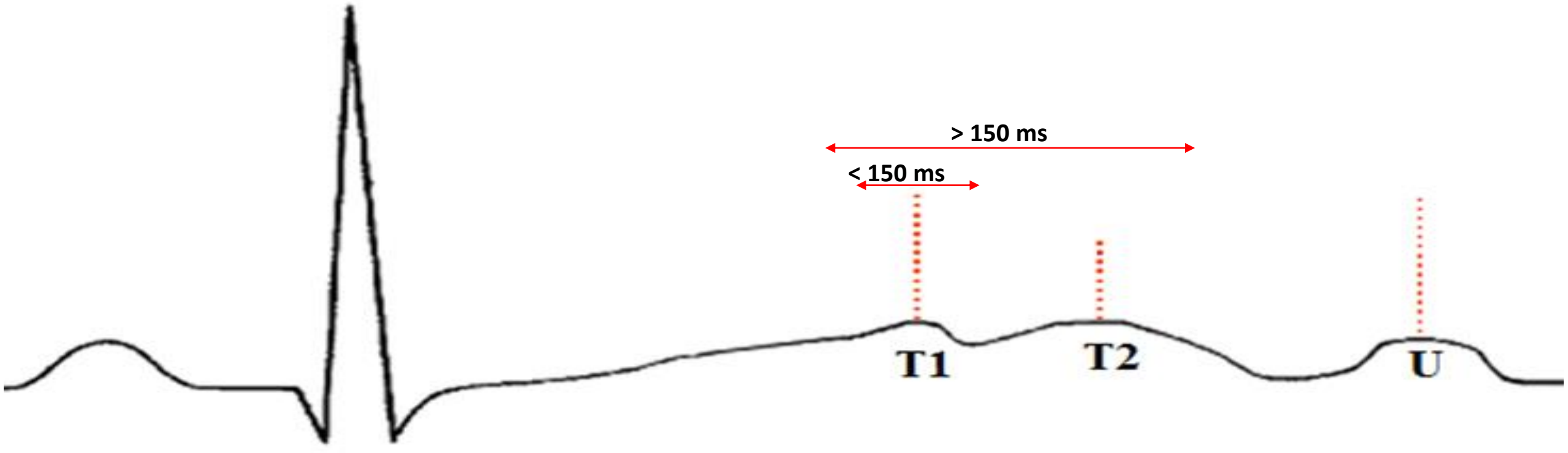
	Men	Women
Very long QTc	≥ 470 ms	≥ 480 ms
Long QT interval	450 ms to 470 ms	460 to 480 ms
Normal QT interval	360 ms to 390 ms	370 ms to 400 ms
Congenital SQTS	< 330 ms	< 340 ms

Differentiation between bimodal T waves of LQT2 from the T-U interval



Characteristics of the HERG LQT2 variant (Lepeschkin 1969; 1972)

Differentiation between bimodal T wave from T-U interval



The second apex of bimodal T wave (T2) is at a distance <150 ms of the first module (T1). The T1-U interval is always >150 ms (Lepeschkin 1956).

Diagnostic Criteria of Long QT Syndrome (Modified from Schwartz et al. [1993])

	Points
ECG findings	
QTc ≥ 480 ms	3
QTc between 460-470 ms	2
QTc = 450 (males)	1
Torsade de Pointes	2
T-wave alternans	2
Notched T-wave in three leads	1
Low heart rate for age	0.5
Clinical history	
Syncope with stress	2
Syncope without stress	1
Congenital deafness	0.5
Family history	
Family members with definite LQTS	1
Unexplained SCD below 30 years old, among immediate family members	0.5

A low probability of LQTS is defined by an LQTS score ≤1 point; an intermediate probability of LQTS is defined by an LQTS score of 2 to 3 points; ≥4 points, high probability of LQTS.