Protocol for obtaining ECG in patients with suspected ARVC/D - 2007

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1) Rhythm strips should be obtained of the precordial leads V1-V6 at double speed (50mm/s) and double amplitude (20mm/mv) in order to compare the duration of the QRS complex (QRSD) in different leads as well as to record the epsilon wave;

2) Rhythm strips should be obtained of leads DI-aVF at double speed (50mm/s) and double amplitude (20mm/mv). Place the left arm lead over the xyphoid process, the right arm lead on the manubrium sternum and the left leg lead over a rib at the V4 or V5 position in order to elicit the epsilon wave.

Localized prolongation of QRSD interval in V1-V3 / QRSD interval in V4-V6 > than 1.2 has been found in 97% of cases of ARVC/D. The QRSD is correlated with the amount of fibrous tissue in patients with VT of RV origin

The sensitivity of this QRS diagnostic criterion has not been established in patients who do not have overt manifestation of this disease. If difference is equal to or larger than 25ms this is favour of slowing of conduction in the RV.

The specificity of this criterion has not been completely established yet in patients without this entity.

In BrS QRS > 110 ms in V1, V2 or V3. It is possible. There is a paper showing that BrS may also present prolongation in QT interval duration from V1 to V3 and consequently prolongation of the QTc interval in the right precordial leads.(Pitzalis MV, Anaclerio M, Lacoviello M, et al. QT-interval prolongation in right precordial leads: an additional electrocardiographic hallmark of Brugada syndrome. J Am Coll Cardiol. 2003; 42:1632-1637). If the QT interval is prolonged only from V1 to V3, being normal from V4 to V6, it is clear that this increase may be due to prolongation of ventricular depolarization (QRS complex) and/or by ST/T prolongation (repolarization). If we admit that in BrS there is some degree of branch block, clearly the QT interval prolongation is due partly to this. The QTc interval constitutes the classical measurement for ventricular repolarization; however, this parameter includes ventricular depolarization (QRS), and therefore represents the so-called electric systole, which includes depolarization (QRS) and ventricular repolarization (ST/T = JT interval). See Figure 6.

Thus, when there is branch block (as in the some cases of BrS), the measurement of ventricular repolarization through QTc may be incorrect. In these cases, the measurement of the JT interval (JT = QT - QRSD) is more accurate than the QT interval, because it excludes the depolarization that is found prolonged, because the biventricular chamber activates sequentially and not concomitantly as normally. This is the reason why it is essential to know accurately the

exact point where depolarization ends and repolarization begins.

Epsilon wave is considered mayor criteria of the diagnosis of ARCVC/D. This fenomenon is characterized by the presence of delayed potentials, which appear after the end of ventricular depolarization as recorded by epicardial mapping. This post-excitation phenomenon may also be demonstrated either by an intracavitary electrode or sometimes on an amplified ECG (Fontaine G, Frank R, Gallais-Hamonno F, Allali I, Phan-Thuc H, Grosgogeat Y. Electrocardiography of delayed potentials in post-excitation syndrome Arch Mal Coeur Vaiss. 1978; 71:854-864.).

This is what is known: In 1977, Fontaine and colleagues provided ananatomical and clinical description of several cases of ARVC/D discoveredduring surgical treatment of VT.

At that time he had personally seen 15 cases with ARVC/D since 1973.In this year Fontaine discovered the epsilon waves. His personal account ofhis discovery was described in his March 5, 1997, letter to Hurst:.....after discovering the first cases of late (or delayed) potentials recorded at the time of surgery on the epicardium of patients with resistant VT. It was quite exciting to demonstrate that these LP located on the freewall of the RV of patients with ARVD could be recorded on the surface by
SAECG and in some circumstances by increasing the magnification of ECG recording. (Fontaine G, Guiraudon G, Frank R, Vede K, Grosgogeat Y, Cabrol C,Facquet J. Stimulation studies and epicardial mapping in ventriculartachycardia: study of mechanisms and selection for surgery. In: Kulbertus HE, ed. Re-entrant Arrhythmias:

Mechanisms and Treatment. Lancaster, Pa: MTP Publishers; 1977:334-350.)

Epsilon waves are often seen in the ECGs of patients with ARVC/D. These waves are best seen in the ST segments of leads V1 and V2. They may be seen
in leads V1 through V4. The duration of the QRS complex may be a bit longer in leads V1 and V2 than in leads V5 and V6. Although the small wiggles may
be seen in the routine ECG, they may be seen more readily in Fontaine leads.
Fontaine described these leads in a letter to Dr Hurst dated September 5, 1997,and reproduced here: "Such leads entail the placement of the right arm electrode (negative) on the manubrium and the left arm electrode (positive) on the xiphoid. This produces a bipolar chest lead. Doubling the sensitivity of the record may also enhance the recording of the epsilon waves.

In addition to the electrode placement described above, the placement of thefoot lead (positive) in position V4 provides, instead of regular leads DI,
DII, and DIII, three bipolar chest leads that can be called FI, FII, and FIII.Tracings are then produced by setting the machine on regular leads DI, DII,and DIII. 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 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 appropiate, because it occurs in the Greek alphabet after delta; thus, delta represents the preexcitation and epsilon the post-excitation phenomenon.