QRS Slurring and Notching in a Healthy Population

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Abstract

"Early repolarisation" has generally been considered benign until recently when it has been associated with life threatening arrhythmias. Because there has been confusion around defining J point elevation in relation to early repolarisation, this study examined ECGs recorded from an apparently healthy adult Caucasian cohort of males and females. As first step, the prevalence of end QRS notching, end QRS slurring and a mixture of both was determined essentially using visual techniques. It was found that almost 29%. of the cohort fell into one or other of these three categories. It is suggested that an internationally agreed definition of what is currently termed "early repolarisation" is required in order to facilitate further studies in this area. .

1.   Introduction

For many years, "early repolarisation" has been regarded as a benign electrocardiographic finding. Most cardiologists would consider early repolarisation as being a pattern of ST elevation with a relatively normal appearing ST segment often in the lateral leads but sometimes in the inferior leads and sometimes in both, with the various forms being found most frequently in younger males in particular.

There have been few clear cut definitions of early repolarisation but the pattern has become associated with a notched terminal portion of the QRS complex [1-3] and according to some other authors, with a slurred termination of the QRS complex [1,2]. Figure 1 illustrates QRS slurring and notching. On the right hand ECG, there is slurring or notching in different leads.

There is no agreed definition of what is meant by a "slur" and a "notch" that could be used by an automated ECG analysis program even although visually these electrocardiographic features can easily be recognised.

The matter has come to a head recently with several publications suggesting that individuals with the above mentioned types of early repolarisation patterns are at a higher risk of suffering a life threatening ventricular arrhythmia compared to those without this pattern [4-6].

The present study was aimed at assessing the variation of this so called early repolarisation pattern in an apparently healthy population by considering different definitions of this pattern.

2.   Methods

12 lead ECGs were recorded in a cohort of apparently healthy individuals with different occupations, employed mainly by Glasgow District Council, in the late 1980s and early 1990s. The population characteristics have been discussed in more detail elsewhere [7].

Resting 12 lead ECGs recorded in digital form at 500 samples/second were recently analysed by the latest version of the University of Glasgow ECG Analysis Program [8]. From this, average beats for each of the 12 leads were printed as were the measurements of the ST amplitude, i.e. QRS termination denoted STj.

Classically, the end of the QRS has been known as the J point – hence the terminology STj.

For this study, if a terminal QRS notch were present, its peak was designated as pkQRSn. This was to avoid any confusion between regarding the peak of the notch as the J point versus the end of the QRS complex which is a point occurring later and of lower amplitude than the peak of the QRS notch. The termination of the QRS complex, i.e. STj was labelled as QRSend.

If a QRS slur was present, its onset was labelled as onQRSslur.

This allows different definitions of end QRS notching and slurring as follows, where $X \geq Y$:

Type 1: $pkQRSn \geq 0.XmV$ and $QRSend \geq 0.YmV$
Type 2: $pkQRSn \geq 0.XmV$ and $QRSend < 0.YmV$.
Type 3: $onQRSslur \geq 0.XmV$ and $QRSend \geq 0.YmV$
Type 4: $onQRSslur \geq 0.XmV$ and $QRSend < 0.YmV$

Figure 2 shows in schematic form some examples of slurring and notching. The slurring and notching is accentuated in order to exemplify the differences between the two types of morphology.

3.   Results

A large cohort of over 1000 adult males and females from the West of Scotland were included in the study.
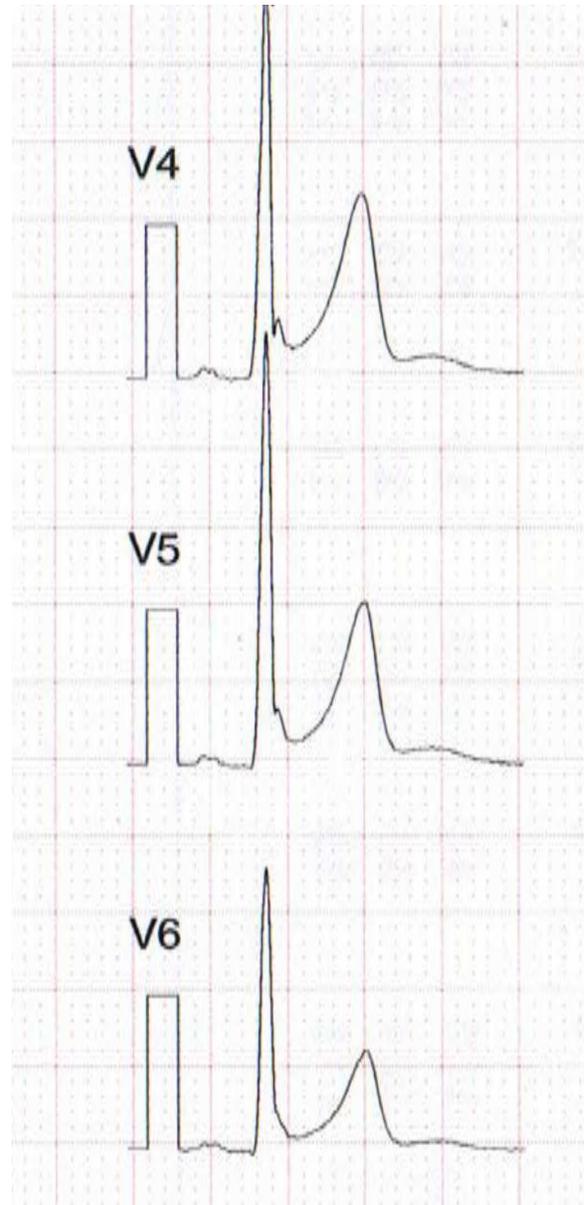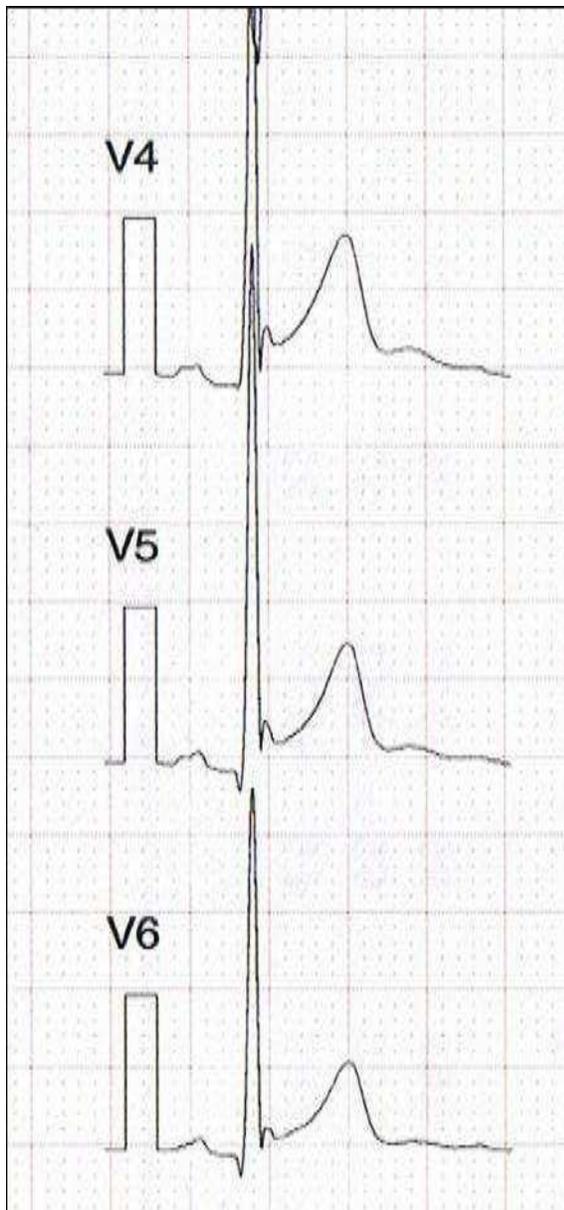
Figure 1.   (Left) Type 1and 2 QRS notching in V4-6.
(Right) Type 3 and 4 slurring in V5-6.

Types 1 & 2
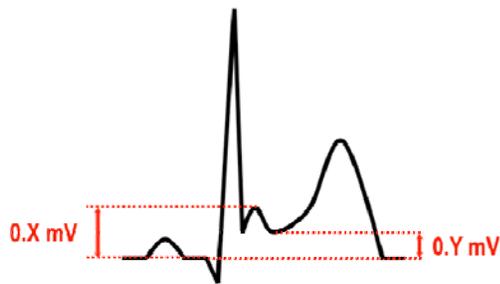
Types 3 & 4
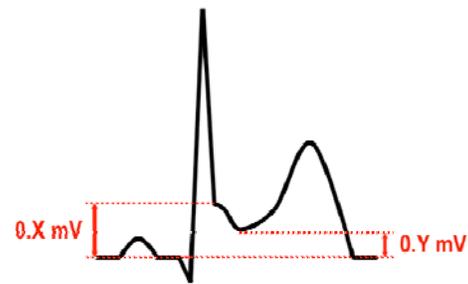
Figure 2. Measures related to potential future classification of notching (Types 1-2) and slurring (Types 3-4). See text for further description.

ECGs were assessed visually by 2 observers who each also had the automated measurement of the amplitude of QRSend available though these were not used in the present report. As a first step, classification of the ECGs into the different types was based purely on visual measurement. It should be noted that the pattern of notching or slurring had to be present in 2 contiguous inferior (II, III and aVF) or lateral (I, aVL or V_4-V_6) leads in order to be recorded as present. Leads V_1-V_3 were excluded from the analysis.

It was found that almost 29% of the group had either QRS slurring, notching or a combination of both. QRS slurring was present more often than QRS notching.

4.   Discussion

QRS slurring was the most prevalent form of so called "early repolarisation" where there was a terminal QRS slurring of any description. The choice of X and Y in any future definition of slurring is important because many physicians would regard an ST junction amplitude Y < 0.1mV as not being consistent with early repolarisation whereas if other authors regard the onset of the slur as being QRS end, then they may report early repolarisation if X exceeds a threshold value perhaps of 0.1mV because effectively they are regarding onQRSslur as equivalent to endQRS or X=Y in this case.

Haissaguerre and colleagues defined early repolarisation as "the elevation of the QRS-ST junction (J point) in at least 2 leads, with the amplitude of the J point elevation at least 0.1mV above the baseline level, either as QRS slurring (a smooth transition from the QRS segment to the ST segment) or notching (a positive J deflection inscribed on an S wave) in the inferior and lateral leads or both" [4]. This definition does not make it clear whether the "J point elevation" is taken as the onset of a slur or the termination. Furthermore, it is not clear

how a J deflection can be inscribed on an S wave which is essentially a negative deflection, i.e. a wave below the level of QRS onset.

A more recent paper by Tikkanen et al [9] has suggested that the ST slope is of more importance than STj amplitude. On the other hand, they gave an example where there was no ST junction elevation whatsoever but rather, there was ST junctional depression together with a downsloping ST segment. The waveform was regarded as consistent with early repolarisation because of a slurred QRS termination with the onset of the slur exceeding 0.1mV. This further highlights the urgent need to have an adequate definition of what is meant by early repolarisation.

In this situation, Y in the definitions given earlier would require to have a negative value, e.g. -0.1mV. It is conceivable that other ECG abnormalities such as left ventricular hypertrophy could also exhibit some terminal QRS slurring and downward sloping ST segment and it is questionable whether this could be termed early repolarisation on the basis of one of the definitions that Tikkanen et al [9] have used.

Defining a notch at the end of the QRS complex creates similar problems to those of defining a slur. An open question is whether or not all of this group, i.e. any ECG with a terminal QRS notch, would be called early repolarisation by a cardiologist. Similarly as for slurring, the critical point is the value of X and Y. Most cardiologists would probably say that X and Y should exceed 0.1mV but some electrocardiologists might settle simply for X = 0.1mV and Y = 0.0mV which would be one interpretation of the Haissaguerre definition [4].

There was a small group of individuals who had a mixed pattern of slurring and notching. An example of this is given in the ECG on the right of Figure 1. It is arguable whether the pattern in V5 on the right hand side is a notch or a slur. In other words, how wide does a

"notch" have to be to be called a notch as opposed to a slur? This is important in respect of using software to report a notch or slur in an automated way. Furthermore, this example suggests that notching and slurring are part of the same underlying electrophysiological process that is manifested in different ways according to its projection onto different ECG leads.

The results of the present work suggest that there is a clear need for a universally accepted definition of what is currently termed "early repolarisation" before any further studies on the relationship between this type of ECG abnormality and the occurrence of life threatening ventricular arrhythmias are undertaken. Further work on defining suitable values of X and Y remains to be done and it is suggested that an international working group or standards group be set up to propose a universally acceptable definition of the pattern called "early repolarisation". Whether or not the name of this entity needs to be changed is another matter as recently highlighted by one of the authors [10]!

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