Available online at www.sciencedirect.com

ScienceDirect

Journal of Electrocardiology 46 (2013) 505 – 509

JOURNAL OF Electrocardiology

www.jecgonline.com

J wave patterns—morphology, prevalence and nomenclature

Peter W. Macfarlane, DSc, FRCP, [a,*] Elaine N. Clark, MA, [a] Jacob S. Heng, MBChB [b]

[a] *Institute of Cardiovascular and Medical Sciences, University of Glasgow, Glasgow, UK*
[b] *Faculty of Medicine, Imperial College, University of London, London, UK*

Abstract The recent resurgence of interest in early repolarization has demonstrated a variation in the definition of the term and a consequent variation in the prevalence of the pattern in different studies. This can vary from 35% in males and 21.5% in females if ST elevation is not considered part of the definition, to 3.3% and 0.5% in females with the inclusion of ST elevation. In contrast, the prevalence of the Brugada Syndrome is in the order of 0.1%–0.2% in Japan for example and has been found to be significantly lower in Denmark. Standardisation of measurement definitions, particularly for early repolarisation, is required.

Keywords: J wave syndromes; Early repolarization

Introduction

ECG change in hypothermia was first noted by Osborn [1] and was manifested as a large wide deflection at the end of the QRS complex which disappeared when the patient was no longer hypothermic. This wave was sometimes called an Osborn wave after the author of the original publication. More recently, the term J wave has been variously used to describe a terminal component of the QRS complex. This may be a relatively wide or narrow wave, or a deflection or notch at the end of the QRS complex. It may also be a more slowly inscribed wave or slur that merges seamlessly with the ST segment. In short, there is a complete spectrum of end QRS waves that have all relatively recently been called J waves. [2]

Another example of a J wave occurs in the Brugada pattern [3] which has been extensively studied and linked with cardiac arrhythmias and sudden cardiac death. [4]

Gussak and Antzelevitch [5] over 12 years ago considered elevation of the J point and ST segment. They considered similarities and differences between the Brugada Syndrome and so called Early Repolarization Syndrome and drew what was at that time the speculative conclusion that the latter might be associated with life threatening cardiac arrhythmias in a similar way to the former. Their paper gives many reasons as to why that might be the case and these are not repeated here. There are many other more recent reviews of the link between J waves and cardiac arrhythmias [e.g. [6,7]].

Renaissance in the J wave

In 2008, Haissaguerre linked end QRS notching and slurring with idiopathic ventricular fibrillation. [8] This was based on a study of 206 patients who had survived sudden cardiac death and had received an implanted cardioverter defibrillator. This precipitated a rush of publications to examine the phenomenon. For example, Tikkanen et al. studied ECGs of patients recorded on paper over 30 years ago and linked the ECG findings with follow up data on this population. [9] These authors subsequently suggested [10] that the slope of the ST segment was important in assessing the prognostic value of early repolarization, defined as an end QRS notch or slur. Downward sloping ST segments were more malignant than horizontal or upward sloping ST segments such as found in athletes, which were regarded as benign.

There were many other publications but the factor which distinguished these studies was the lack of a common definition of what was now being more frequently called "early repolarization".

Early repolarization

The descriptive features of early repolarization have been in the literature for years. In 1951, in a paper on spatial vector electrocardiography, Grant, Estes and Doyle [11] referred to the ST vector due to "normal early repolarization forces" being difficult to distinguish from those due to acute pericarditis. Goldman [12] described RS-T segment elevation in mid and

* Corresponding author. University of Glasgow, Institute of Cardiovascular and Medical Sciences, Electrocardiology Group, Level 1 QEB, Royal Infirmary, Glasgow G31 2ER.
E-mail address: peter.w.macfarlane@glasgow.ac.uk

0022-0736/$ – see front matter
http://dx.doi.org/10.1016/j.jelectrocard.2013.08.013

left precordial leads as a normal variant. This was particularly the case, in his view, if the ST elevation disappeared on exercise. In a form of reverse logic for the creation of ST elevation, Goldman suggested that the normalisation of the ST segment was due to accelerated depolarization or delayed repolarization. In 1962, Wasserburger and Alt in their paper[13] on the normal elevated ST segment referred to the cause as being due to "a distinct notch or slur on the distal QRS complex". Their description of this normal variant also included a "symmetrically limbed T wave which is often of large amplitude".

One of the earliest reports to consolidate the use of the term "early repolarization" was from Kambara and Philips.[14] In their study, 80% of 65 individuals with the pattern were black. The pattern was seen to be present mainly in precordial leads and not in inferior leads alone. Of interest was the fact that these authors found persistence of the pattern "for decades in many patients".

The term early repolarization, however, has not met with universal acceptance. It was Spodick[15] who indicated that early repolarization was an under investigated "misnomer". He postulated that the pattern might be due to late depolarization rather than early repolarization. A similar suggestion was also made by Wellens.[16]

This led one of the authors to be associated with a publication on J wave syndromes and early repolarization, suggesting that these were inappropriate and confusing electrocardiographic terms.[17] Part of the reason for that is that an electrocardiographic syndrome such as the WPW syndrome[18] is a combination of an electrocardiographic pattern and clinical symptoms. In the case of the WPW syndrome, the electrocardiographic abnormality is the well known delta wave at QRS onset and the clinical abnormality is palpitations/chest discomfort, with or without syncope, arising from a tachycardia involving an accessory pathway between the atria and ventricles.

It therefore follows that an abnormal ECG waveform can not be called a syndrome. It could be argued that, before a pattern could be linked with a syndrome, there has to be a reasonable incidence of individuals demonstrating symptoms that could be linked with the ECG morphological abnormality. In turn, this leads to a discussion as to whether an ECG morphology with a high prevalence not associated with any symptoms in the vast majority of those with the pattern should be called a syndrome.

With respect to inappropriate terms, the debate on end QRS notching, for example, being due to early repolarization or late depolarization is ongoing and is not one to be reproduced in this manuscript.

Prevalence

A discussion on prevalence of early repolarization really relates to a discussion on the definition of the ECG morphological abnormality. With respect to the current topic, Haissaguerre et al.[8] described early repolarization as an elevation of the QRS–ST junction (J point) in at least 2 leads. The amplitude of the J point had to be at least 0.1 mV 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 the S wave") in the inferior lead (II, III and aVF), lateral lead (I, aVL and V4–V6) or both. The anterior precordial leads (V1–V3) were excluded.

One comment to be made here is that a positive J deflection cannot be inscribed on an S wave because if an S wave exists, any following wave classically would be an R′ wave. A second point arising from this definition is that the J point is described as the QRS–ST junction. This would be disputed by some authors [e.g.[19]] if the J point under discussion was associated with a notch, as in Fig. 1.

To be objective, Tikkanen et al. used a very similar definition[9] to that of Haissaguerre et al.[8] but separated the cases depending on whether the J point was ≥ 0.1 mV or >0.2 mV.

As a matter of record, the 2010 Minnesota Code[20] had a different definition of early repolarization which was as follows:

STj elevation ≥ 1 mm in the majority of beats, T wave amplitude >5 mm, prominent J point, upward concavity of the ST segment and a distinct notch or slur on the downstroke of the R wave any of V3–V6; or, STj elevation ≥ 2 mm in the majority of beats and T wave amplitude ≥ 5 mm, prominent J wave and upward concavity of the ST segment in any of V3–V6 without the distinct notch on the downstroke of the R wave. The inferior leads, as well as I, aVL appear to be have been ignored in this definition while V3 has been included. The J point appears to be separated from ST-J elevation.

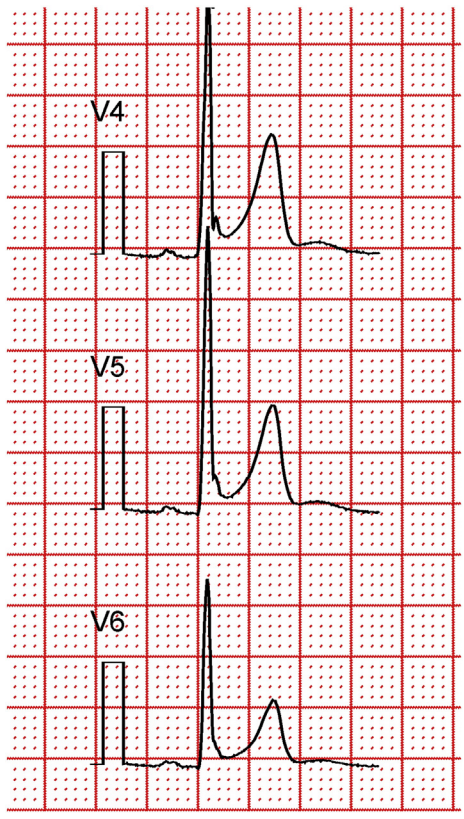

Fig. 1. Simultaneously recorded ECG waveforms with an end QRS notch in V4 changing to a slur in V6. Color illustration online.