Early repolarization pattern (ERP) is a common ECG variant, characterized by J point elevation manifested either as terminal QRS slurring (the transition from the QRS segment to the ST segment) or notching (a positive deflection inscribed on terminal QRS complex) associated with concave upward ST-segment elevation and prominent T waves in at least two contiguous leads.\(^1,2\) The J point deflection occurring at the QRS-ST junction (also known as Osborn wave or J wave) was first described in 1938, and is seen in both extracardiac and cardiac disorders like hypothermia, hypercalcemia, brain injury, hypervagotonia, or spinal cord injury leading to loss of sympathetic tone, vasospastic angina. Besides recently described early repolarization syndrome,\(^3-5\) ERP has generally been considered a normal ECG variant with good long-term prognosis. However, this long-held concept has been challenged, and recently published population-based studies and reports of associations with ventricular fibrillation and sudden death continue to fuel more momentum.\(^6-9\) In the seminal article by Haïssaguerre et al, cases of ERP associated with cardiac arrest had at least 0.1-mV J point elevation manifested as QRS slurring or notching in the 2 contiguous inferior or lateral leads.\(^6\) ERP has also emerged as a marker of increased long-term mortality (cardiac and arrhythmic) in the general population.\(^10,11\) Thus, ERP is probably not as benign as traditionally believed.

**Definition of Early Repolarization**

A Tug of War

Nicolas Derval, MD; Ashok Shah, MD; Pierre Jaïs, MD

Early repolarization pattern (ERP) is a common ECG variant, characterized by J point elevation manifested either as terminal QRS slurring (the transition from the QRS segment to the ST segment) or notching (a positive deflection inscribed on terminal QRS complex) associated with concave upward ST-segment elevation and prominent T waves in at least two contiguous leads.\(^1,2\) The J point deflection occurring at the QRS-ST junction (also known as Osborn wave or J wave) was first described in 1938, and is seen in both extracardiac and cardiac disorders like hypothermia, hypercalcemia, brain injury, hypervagotonia, or spinal cord injury leading to loss of sympathetic tone, vasospastic angina. Besides recently described early repolarization syndrome,\(^3-5\) ERP has generally been considered a normal ECG variant with good long-term prognosis. However, this long-held concept has been challenged, and recently published population-based studies and reports of associations with ventricular fibrillation and sudden death continue to fuel more momentum.\(^6-9\) In the seminal article by Haïssaguerre et al, cases of ERP associated with cardiac arrest had at least 0.1-mV J point elevation manifested as QRS slurring or notching in the 2 contiguous inferior or lateral leads.\(^6\) ERP has also emerged as a marker of increased long-term mortality (cardiac and arrhythmic) in the general population.\(^10,11\) Thus, ERP is probably not as benign as traditionally believed.

The potential consequences of such an association are huge, especially as related to ECG screening and risk stratification in the general population. It is therefore extremely important to read carefully in between the lines the criteria used for the selection of the population. In this regard, the definition of ERP in these reports is crucial, because differences in definition used in studies with inhomogeneous population screening will introduce confusion. It is important to note that, in all the published studies demonstrating a link between ERP and sudden cardiac death, the presence of J point elevation (notch/slur), irrespective of the presence of ST-segment elevation, was the key component of the definition of ERP. Leads \(V_1\) through \(V_3\) were not included in the definition to exclude Brugada syndrome and arrhythmogenic right ventricular cardiomyopathy.

In the current issue of *Circulation*, Uberoi et al\(^{12}\) have evaluated the association of ST elevation on cardiovascular mortality in an ambulatory clinic population of approximately 29,000 patients followed longitudinally (for 7.6±3.8 years). This population is extracted from 45,829 inpatient and outpatient ECGs recorded between 1987 and 1999 at the VA Palo Alto Health Care System. All patients with obvious ECG abnormalities (arrhythmia, conduction abnormalities, ventricular preexcitation, etc) and with an inpatient status (because no clinical diagnostic code was available) were also excluded from analysis (n=12,319). The following points were used to define the population as ERP positive: (1) PR segment defined the isoelectric line; (2) ST elevation measured at the end of QRS complex; (3) J waves defined as an upward deflection, slurs as a conduction delay beginning on the QRS down stroke; (4) requirement of 2 contiguous leads with ST elevation or J wave was not always fulfilled, especially if the group size was less than 1% of the total population, so 1 lead affection was considered sufficient for inclusion; (5) ST elevation or J wave occurring in the anterior leads (\(V_1\) through \(V_4\)) were not excluded. ECGs of the entire population were analyzed by computer-read values, but only for the ST elevation. Manual rereading was performed for all the ECGs exhibiting ST elevation. The authors also manually analyzed the ECGs of a subset of patients (n=4,041, 14% of the population) for the prevalence of J wave using the above-mentioned definition. Mean follow-up was 7.6±3.8 years.

Their main findings can be summarized as follow: ST elevation was present in 2.3% (n=664) and was present in both inferior and lateral territories in only 0.1% (n=43) of the population studied. Adjusted hazard ratio demonstrated that ST elevation in inferior and/or lateral leads was not associated with increased mortality and even showed a trend toward decreased mortality. In the subset of patients with ECGs available, J wave (notch/slur) was present in 14% (n=583) and more frequent in those with ST elevation than those without (61% versus 13%; \(P<0.001\)). Adjusted hazard ratio demonstrated no association among J wave (notch/slur), ST elevation, and cardiovascular mortality; rather, they showed a trend toward decreased mortality.

The authors of this study conclude that ST elevation is not associated with increased cardiovascular mortality in asymptomatic patients and reassert the long-held belief that ECG J point (concave upward ST segment) elevation is benign. Although this article brings to the forefront the complexity of risk stratification of patients with so-called ERP in an asymptomatic population, there are methodological concerns that should be considered in relating these results to other...
recently published studies on ERP. The selected population is markedly different from other, community-based populations. Included patients are older (55±14 years), almost exclusively male (87.2%), and predominantly overweight (mean BMI 27.3±5.5). They exhibited a high prevalence of evidence of coronary artery disease on ECG (26.6%). Of note, 7.1% of the patients had inferior Q waves that may have masked the presence of inferior J wave. Altogether, these biases in population selection need to be taken into consideration. Now, if the population studied was composed of old, white, sedentary men, it explains the rather low proportion of ST-segment elevation pattern that is more frequently present in a young, black, athletic population. However, it remains surprising that the authors report such a high incidence of J waves, which should have been less frequent in this population. But, in our opinion, the most controversial aspect of the present study is semantic. In the present study, the authors decided that the terminology “early repolarization” should be considered synonymous with concave upward ST elevation with and without J wave or slurring of the down slope of the R wave, which is its conventional meaning. The widely used term “early repolarization” has been generated by electrocardiographers to describe, in most cases, a normal variant of ST-segment elevation. The American College of Cardiology (ACC)/American Heart Association (AHA)/Heart Rhythm Society (HRS) recommendations for the standardization and interpretation of the ECG include a statement that the term “early repolarization” is used frequently to characterize a normal QRS-T variant with J point elevation. In that sense, early repolarization is benign. However, recent scientific studies that used the same terminology for terminal QRS notch or slur ignored ST elevation. Every result that was demonstrated in these studies under the terminology “early repolarization” (high prevalence in survivors of sudden cardiac death, increased risk of arrhythmic mortality [not overall mortality] in the general population [cohort studies]) used a definition based on the presence of inferolateral J wave abnormality (notch/slur) irrespective of ST-segment elevation. Thus, by mere expansion of its definition, the terminology of ERP was rendered not as benign as previously considered. This inappropriate use of terminology is certainly an important cause of confusion.

Besides these controversial points, the article by Uberoi et al contains some important messages. In a large population of asymptomatic patients, isolated ST-segment elevation is not associated with increased risk of cardiac death. In a smaller subgroup of patients in which the authors analyzed all ECGs manually using a similar definition as previously published, J wave abnormality with or without ST elevation is not associated with increased risk of cardiac death.

These results challenge the recent consensus that ERP is not as benign as was believed and highlights the need for a large, prospective registry to better understand the nature of ERP.

Disclosures

None.

References


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