The JT Interval as a Depolarization Independent Measurement of Repolarization: Lessons from Catheter Ablation of the Wolff-Parkinson-White Syndrome

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SALIM, M.A., ET AL.: The JT Interval as a Depolarization Independent Measurement of Repolarization: Lessons from Catheter Ablation of the Wolff-Parkinson-White Syndrome. In patients with Wolff-Parkinson-White syndrome (WPW), preexcitation precludes accurate assessment of the ventricular repolarization by the QT interval. In patients with long QT syndrome, it has been demonstrated that the JT interval does not change when depolarization abnormalities develop. We hypothesized that this phenomenon should also be applicable to WPW patients. To test this, we assessed the surface ECG of 29 patients (16 males, 13 females) with WPW pre- and postablation. The QRS, QT, and JT intervals were measured pre- and postablation at 50 mm/s paper speed in leads II and V2. QT, and JT were calculated according to Bazett's formula. The average age was 12.8 ± 4.9 years (range 1.5–21). All patients had no residual preexcitation on postablation ECG. Early and late follow-up ECGs were obtained at 32 ± 34 days and 388 ± 197 days postablation, respectively. Both the QRS and the QT intervals shortened significantly on the postablation versus preablation ECGs (QRS: 115 ± 23 ms vs 89 ± 15 ms, respectively; P < 0.0001), (QTc: 454 ± 26 ms vs 423 ± 23 ms, respectively; P < 0.0001). The preablation JT interval did not change, postablation (319 ± 21 ms vs 323 ± 23 ms, respectively; P > 0.2). Also, the JT interval did not change between early and late follow-up, postablation. JTc is an independent measure of repolarization, not related to depolarization. JT may be a useful tool in assessing repolarization in patients with WPW and other depolarization abnormalities. (PACE 1995; 18:2158–2162)

**JT interval, QT interval, ventricular repolarization, preexcitation**

**Introduction**

Depolarization abnormalities in patients with Wolff-Parkinson-White syndrome (WPW) and other causes of wide QRS complexes may preclude accurate measurement of repolarization as assessed by the QT and corrected QT (QTc) intervals. The JT and corrected JT (JTc) intervals represent the specific ventricular repolarization time, and has been shown, in patients with long QT syndrome, to be independent of the QRS duration. To further explore this phenomenon, we hypothesized that in patients with WPW (i.e., wide complex QRS), the JT interval corrected to heart rate will not change following catheter ablation of accessory pathways and disappearance of preexcitation. As such, in the presence of abnormalities of ventricular activation, the JT interval, rather than the QT interval, may be a more reliable measure of repolarization.

**Methods**

We retrospectively reviewed 29 patients with WPW who had successful radiofrequency ablation of their accessory pathways. Electrocardiograms in the resting supine position, before and after ablation, were evaluated. Only patients with visible preexcitation on surface electrocardiograms were included in this study. All measurements were made manually (Fig. 1), with the aid of a caliper, from limb lead II electrocardiograms, and chest lead V2 at 50 mm/s paper speed at 20 mm/1 mV.
JT INTERVAL IN WPW

Figure 1. The measurement of the QRS, QT, and JT intervals in lead II in a patient with Wolff-Parkinson-White syndrome. Panel A: Measurements prior to ablation. Panel B: Measurements after ablation.

(Marquette Electronics, Inc., Jupiter, FL, USA) at 100-Hz filtration (program 107A, 12SLtm v78). Lead II was chosen as recommended by Moss et al.2 in the international study of patients with long QT syndrome. Also, the T wave in lead II is a single large wave without a large U wave,3 making it easier to determine its endpoint. Lead V2 was chosen because it has the largest T wave amplitude and the longest QT interval.4 The QRS complex duration was determined between its initial depolarization (the beginning of the delta wave prior to ablation) and the J point. When the landmarks at the end of the QRS complex were distinct, the J point was determined as the beginning of the isoelectric S-T segment. If, on the other hand, the landmarks were not distinct, the J point was the intercept point between a tangent to the descending part of the R wave or the ascending part of the S wave and the isoelectric line drawn through the S-T segment.5 The end of the T wave was the intersection between a tangent to the downslope of the T wave and the isoelectric line.4 Measurements included the PR, the QRS, the QT, and the JT intervals. The RR interval was averaged over 5 consecutive beats. Bazett’s formula was used to correct for heart rate, whereas: QTc = QT/√RR, and JTc = JT/√RR.

Statistical analyses were performed on Stat-View 4.0 software (Brainpower, Inc., Calabasas, CA, USA). Paired and unpaired Student’s t-test were used where applicable. Correlation was determined by regression analysis. A P value < 0.05 was considered significant.

Results

The study population consisted of 16 males and 13 females. The mean age at ablation was 12.8 ± 4.9 years (range 1.5–21). All patients had at least one electrocardiogram prior to ablation that showed obvious ventricular preexcitation. Early follow-up electrocardiograms postablation were obtained after a mean follow-up duration of 32 ± 34 days (range 1–165, median 38). Because of the retrospective nature of the study, the first electrocardiogram available for analysis was considered as the early follow-up electrocardiogram.

There were ten electrocardiograms obtained in the first 2 days postablation. Long-term follow-up electrocardiograms were available for 12 patients, 388 ± 197 days (range 98–794) postablation. Ablation was considered successful in all patients, by electrophysiological testing, immediately after the procedure. In addition, no postablation electrocardiogram showed any residual preexcitation. Table I summarizes the values of the measurements obtained. When contrasting the pre- and early postablation values, as expected the QRS, PR, and QTc were significantly different in both leads. However, the JTc pre- and postablation were comparable, suggesting a similar repolarization time intervals. Late follow-up of the postablation patients have shown no significant change in the JTc when compared to either the preablation or the early postablation values. The QRS complex contribution to the QT interval, in lead II, was 29% ± 5% preablation, compared to 24% ± 3% postablation (P < 0.0001). There was a significant cor-
relation between the QT and QRS duration before 
(r = 0.55; P < 0.002) and after (r = 0.45; P < 0.02) 
ablation. The JT interval, on the other hand, did 
not correlate with either pre- or post-ablation QRS 
duration. Preablation, the QTc values were similar 
between males and females, while the JTc values 
of the male patients were significantly shorter than 
the female values (P < 0.003). Postablation, the 
JTc and QTc values for male patients tended to be 
shorter than those for female patients. All patients 
had normal JT index according to Zhai et al. and 
normal JTc value according to Zareba et al., both 
pre- and postablation. The QTc values were normal 
in all patients except one. This patient had com-
plete right bundle branch block and a prolonged 
QTc of 466 ms, however, his JTc was normal (303 
ms).

Preablation, there was no significant differ-
ence in the JTc or the QTc values between the two 
leads used. Postablation, both the QTc and the JTc 
values were shorter in lead V2 than lead II (QTc: P 
< 0.04; JTc: P < 0.006).

Discussion

The measurement of the QT and the rate cor-
corrected QTc is a cornerstone in the diagnosis of the 
congenital long QT syndrome. Acquired prolon-
gation of the QTc has been associated with in-
creased mortality after myocardial infarction, and
in patients with chronic ischemic heart disease. In 
the presence of intraventricular conduction ab-
normalities, the prolongation of the QRS produces 
a prolonged QT interval and as a result, a pro-
longed QTc. Das found a significantly longer QTc 
interval, in patients with left axis deviation, right 
bundle branch block, and left bundle branch 
block, compared to normal controls. However, the 
JT interval and a value derived by subtracting the 
QRS complex duration from the QTc interval (JTc 
– QRS), were similar between patients and con-
trols. In patients with dilated cardiomyopathy the 
QTc was significantly longer in nonsurvivors com-
pared to survivors. The JT and the QTc-QRS in-
tervals of patients who died of congestive heart 
failure were similar to those of survivors. How-
ever, patients with dilated cardiomyopathy who 
died suddenly had significantly longer JT and QTc-
QRS intervals than both survivors and those who 
died of congestive heart failure. We elected to cal-
culate the JTc interval according to the method de-
scribed by Zareba et al., because it allowed us to 
compare the values of the JTc interval of our pa-
tient population to their reported normative data.

Our data show that the QTc in patients with preexcitation may be an inaccurate measure of ventricular repolarization because of the inclusion 
of an abnormally wide QRS complex in the calcu-
lation. The QT interval represents both ventricular 
depolarization and repolarization and, as such, is
The JT interval reflects the repolarization in the basal portion of the right and left ventricles, and is independent of the ventricular depolarization. The patients with WPW represent a unique population in that they have normal cardiac anatomy, and with the ablation of the accessory pathway regain normal cardiac conduction. Yet, in this group the JT intervals did not change while the QTc values changed significantly, and on late follow-up there was no significant change from the preablation values. This is similar to data reported in long QT syndrome patients who had no change in their QTc after developing a wide QRS because of bundle branch block or ventricular pacing.

The association between prolonged JT and JTc intervals in patients with the long QT syndrome, and those with cardiomyopathy and sudden death, may provide a valuable tool in the evaluation of repolarization abnormalities in patients with depolarization abnormalities. In the WPW patient population, the JTc proves the presence of normal ventricular repolarization and may be helpful in their management especially before ablation. In the presence of a prolonged JTc interval prior to ablation, an antiarrhythmic drug that is known to prolong repolarization could, theoretically, be detrimental and should be avoided if possible. Our data as well as the works of others may provide further support to those calling for the substitution of the JTc interval for the QTc interval in the evaluation of ventricular repolarization.

By measuring the QT and JT intervals from two different leads we were able to better isolate any influence a flat delta wave may have had on the values obtained. There were differences between the leads, as the QTc and the JTc values in lead V2 were shorter postablation than those of lead II. However, within the same lead the JTc was consistently similar and the QTc shortened after ablation.

Our study did not attempt to evaluate the qualitative changes of the T wave morphology observed in the early postablation period. Previous reports described these changes in the T wave vector without evaluating the changes in the repolarization duration. Moreover, these changes in the T wave vector were observed in the first few days following ablation. The electrocardiograms evaluated, in our study, were obtained in most of the patients beyond the initial follow-up period.

Theoretically, further support for this study could be derived from the measurement of the QT and the JT intervals with and without right ventricular pacing, or at different sites within the ventricle during an electrophysiological study. However, whether repolarization parameters measured during electrophysiological testing are similar to those on standard electrocardiogram needs further study before we can use it. The different response characteristics of each recording instrument may produce large variations in the values obtained. It has been shown that the QT interval measured from a 24-hour continuous electrocardiographic monitoring is different from that obtained on the standard electrocardiogram. Comparing these values may not be accurate.

In summary, these data suggest that the use of the JTc interval is a more specific measure of repolarization and should be considered as a valid substitute to the QTc interval, especially in the presence of abnormal ventricular activation.

Acknowledgments: Our thanks to Dr. Joel B. Cochran, Christine A. McKay, and Fred Varney, Jr., for their assistance.

References


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