Lengthening of the descending branch of the T wave and an abnormal dbT/jT index on the electrocardiogram as poor prognostic factors in patients with COVID-19 in intensive care

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Abstract

Proposition: dbT lengthening and the Tp-Te interval index on the electrocardiogram can improve the detection of left ventricular hypertrophy and dysfunction. These abnormalities are found in conditions other than hypertension, and their presence is associated with a worse prognosis.

Objective: to evaluate dbT lengthening and/or the dbT/jT index in patients with COVID-19 treated in the ICU, as poor prognostic factors.

Materials and method: an observational, descriptive, retrospective cross-sectional study. Twenty patients with COVID-19 admitted to the ICU, with an EKG, were included, measuring dbT, calculating the dbT/jT index and relating them to the number of deaths and days of ICU stay.

Results: the most appropriate leads for measurement were V2-V3 and V4. A dbT ≥ 93 milliseconds in V2 and V4 was found in 60% of the patients, with a higher number of deaths; a dbT/jT index ≥ 0.40 was found in 45% of the cases and was related to a trend toward more hospital days.

Conclusions: both patients with a dbT ≥ 93 ms and those with a dbT/jT index ≥ 0.40 in the V2-V4 electrocardiographic leads tended to have longer hospitalizations as well as more deaths. **(Acta Med Colomb 2024; 49. DOI: https://doi.org/10.36104/amc.2024.2824).**

Keywords: *dbT lengthening on EKG, dbT/jT index on EKG, independent poor prognostic factors.*

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Introduction

In electrocardiography, the T wave represents ventricular repolarization. The interval from the beginning of the QRS complex until the apex of the T wave is known as the absolute refractory period. The last half of the T wave is known as the relative refractory or vulnerable period. The T wave contains more information than the QT interval. The T wave can be described by its symmetry, asymmetry, slope of the ascending and descending branches, amplitude and subintervals like the Tpeak-Tend (Tp-Te) interval (1). (1).

In most leads, the T wave is positive, due to membrane repolarization. During ventricular contraction (the QRS complex on the electrocardiogram [ECG]), the heart depolarizes. Ventricular repolarization occurs in the opposite direction from depolarization and is a negative current, indicating ventricular relaxation. This double negative in direction and charge is the reason why the T wave is positive; although the cell acquires a mostly negative charge, the net effect is in a positive direction, and the ECG reports this as a positive peak (2).

However, a negative T wave is normal in the AVR lead. The V1 lead may have a positive, negative or biphasic T wave, where the positive wave is followed by a negative wave, or vice versa. Furthermore, it is not unusual to have an isolated negative T wave in leads III, AVL or AVF. A periodic beat to beat variation in the amplitude or shape of the T wave can be termed T-wave alternans. Tp-Te is the result of the global distribution of the depolarization process. The Tp-Te interval, defined as the distance between the peak and end of the T wave, is expressed in millimeters (3, 4).

In Ferruci et al.'s study (5), Tp-Te was significantly greater in hypertensive outpatients than in normotensive individuals, with the following absolute values reported: 2.9554±0.52002 mm vs. 2.2234±0.32531 mm; p <0.001. In addition, an analysis of the operating characteristics showed an area under the curve of 0.886 (range, 0.795–0.977) for the log Tp-Te interval, 0.528 (range, 0.357–0.698) for log VAT and 0.494 (range, 0.318–0.670) for log P duration.

Additional ECG indices have been proposed, including P wave analysis and the Tp-Te interval to improve the

detection of left ventricular hypertrophy (LVH) and left ventricular (LV) dysfunction. In particular, the available evidence has shown significant, positive and independent correlations between increased LV mass and a prolonged Tp-Te interval, which has been seen as an index of abnormal transmural dispersion of LV repolarization. These findings, however, have been obtained in various clinical conditions other than hypertension, a condition in which both LV hypertrophy and LV dysfunction are extremely common and are independently related to a worse prognosis (6-8).

The objective of this study was to evaluate dbT and/or dbT/jT index (the descending branch of the T wave/interval from the J point to the end of the T wave) lengthening as poor prognostic factors in patients with COVID-19 in intensive care.

Materials and method

A 12-lead ECG was obtained on admission and every seven days until ICU discharge for all patients over the age of 18 hospitalized for COVID-19 and treated at the institution with intensive care, intubation and ventilatory support from June 2020 to February 2022, obtaining the following from each lead:

- The measurement of the descending branch of the T wave in milliseconds (ms), determining in which lead or leads it is most evident, and taking 0.93 ms as the cut-off point, according to Haarmark et al.›s report (1).
- The dbT/jT index: (the interval from the peak of the T wave to the isoelectric line / the interval from the J point to the end of T), measured in each lead, calculating the mean, and taking a dbT/jT index ≥ 0.40 as the cut-off point, corresponding to more than 2 standard deviations away from the mean, according to Cosgun et al.'s report (9).

The number of days in the ICU was calculated for all cases.

Statistical analysis

Since the sample amounted to n=20, Fisher's exact test was used to compare percentages of the categorical variables. P values <0.05 were considered statistically significant.

Results

We obtained a sample of 20 patients who met the inclusion criteria (n = 20). On the ECG, the T wave, jT interval and descending branch of the T wave (dbT) were best measured in the precordial V2, V3 and V4 leads (Table 1). Using a cut-off point ≥93 ms for dbT, this occurred in V2 and V4 (n =12/20) in 60% of the cases, respectively, and in 65% of the patients in V3 (n=13/20).

On the other hand, a dbT/jT index with a cut-off point ≥0.40 was found in V2 (n = 9/20) in 45% of the cases; in V3 (n=6/20) in 30% and in V4 (n = 5/20) in 25%.

The total deaths in the sample amounted to 20% (n = 5/20), corresponding to four out of 12 patients with a dbT ≥ 93 ms in V2 (30%), and four deaths out of nine patients (44%) with a dbT/jT index ≥ 0.40 in V2, with a p = 0.6, which was not statistically significant.

Values of dbT ≥ 93 ms and a dbT/jT index ≥ 0.40, considered abnormal, appeared beginning with the second EKG in 6/20 cases and the third EKG in 12/20 and 13/20, respectively. These abnormalities persisted over time in the patients who died (n=5/20), and in only one case were found on the first ECG, corresponding to a patient who died on the fifth day in the ICU, with an estimated 68% sensitivity as a predictor of death.

Table 1. *Average measurement in milliseconds of the descending branch of the T wave, jT interval, and dbT/jT index in all 12 electrocardiographic leads in 20 patients hospitalized in intensive care for COVID-19.*

Lead	dbT (ms)	dbT range (ms)	jT (ms)	dbT/jT index	Range (ms)
I	80.52	40-200	323.0	0.25	0.07-0.83
II	94.70	40-240	346.1	0.26	0.08-0.75
II	74.00	40-120	287.6	0.27	0-09-0.41
AVR	83.33	40-200	312.7	0.27	0.07-0.83
AVL	62.00	20-160	300.0	0.23	0-09-0.66
AVF	61.00	40-160	311.4	0.23	0-04-0.72
VI	98.66	40-200	306.6	0.32	0.15-0.71
V2	116.00	40-220	323.8	0.37	0.30-0.60
V3	126.42	80-320	348.2	0.37	0.25-0.66
V4	121.25	60-360	357.8	0.33	0-13-0.75
V5	102.10	40-400	338.0	0.29	0.14-0.83
V6	102.66	60-200	341.8	0.28	0.14-0.62

dbT= descending branch of the T wave; jT interval in milliseconds from the J point to the end of the T wave; ms = milliseconds.

Regarding the study sample's length of stay in the ICU, we found that patients with a dbT/jT index ≥ 0.40 (n =9) in leads V2-V4, had an average length of hospital stay of 37 days, compared to patients with a dbT/jT index < 0.40 (n =11), whose average length of stay was 28 days.

For patients with a dbT ≥ 93 ms in leads V2-V3 (n=13), the average length of hospital stay was 30 days, unlike patients (n =7) with a dbT < 93 ms in leads V2-V3, whose average hospital stay was 47 days.

Discussion

Total repolarization of the epicardial action potential coincides with the peak of the T wave, and M cell repolarization coincides with the end of the T wave. Thus, cardiac M cell repolarization generally determines the QT interval. It has been suggested that the interval between the peak and end of the T wave (Tp-Te) provides an index of transmural dispersion of repolarization that could have prognostic value (10).

According to Cosgun et al.'s report (9), a dbT/jT index with a cut-off point of ≥ 0.40 is situated more than two standard deviations from the mean; therefore, it is abnormal and should undergo specialized study for probable diastolic dysfunction in patients who have it, looking for risk of death (10).

However, unlike dbT lengthening beyond 93 ms, the dbT/jT index could indicate right ventricular repolarization disruptions due to pressure overload in the right ventricle, as well as ventricular arrhythmia caused by inotropes or other medications.

Since the abnormal dbT/jT index values appeared in the patients seven to fourteen days after admission and were not present on admission to the ICU, this suggests the severity of multisystemic involvement in the study participants. Both the presence and persistence of these abnormalities are poor prognostic factors.

This study found no statistically significant difference in terms of the dbT/jT index (p =0.6), unlike dbT lengthening beyond 93 ms; therefore, according to these results, dbT interval lengthening greater than 93 ms in leads V2, V3 and V4 correlates with a poor prognosis in at least 60% of the cases in which it is found.

This study's flaws include a) a very small number of patients, b) dealing with a disease whose treatment was initially unknown, c) the number of medications which ICU patients at times require, and d) the patients' prior comorbidities like hypertension, diabetes, overweight, etc. Thus, more cases are needed to confirm this observation before asserting the reliability and usefulness of the data, including patients hospitalized in the ICU with diagnoses other than COVID-19 infection.

Conclusion

Both patients with dbT ≥ 93 ms, as well as those with a dbT/jT index ≥ 0.40 in electrocardiographic leads V2-V3 were found to have longer hospital stays as well as more deaths. Further studies are needed in ICU patients with COVID-19 as well as patients with other conditions without COVID-19 to corroborate the association between an abnormal dbT length and dbT/jT index and the clinical prognosis.

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