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Qtc Interval Dispersion in Patients with Acute Stroke

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Abstract

Background: QT, QTc interval and QTc dispersion express the inhomogeneity of left ventricular repolarization time. Its extension results in an increase of vulnerable period and susceptibility to malignant arrhythmias in patients with cardiovascular and cerebrovascular disease and hence sudden death.

Objective: To evaluate the QTc dispersion in patients with acute stroke.

Materials and Methods: 30 patients admitted to the emergency service of the University Hospital Dr. Manuel Nunez Tovar diagnosed with acute stroke were selected. All patients underwent 12-lead electrocardiogram (ECG) baseline to quantify the QT, QTc interval and QTc dispersion and computed tomography with cross sections to assess the extent, compromised cerebral territory and etiology. Cardiovascular risk factors were considered and followed during the period of hospitalization. Patients with atrial fibrillation were excluded. **Results:** Cardiovascular risk factors: hypertension 25(83.3%) Smoking 12(40%), prior stroke 7(23.3%), diabetes 6(20%), coronary artery disease 4(13.3%) and arrhythmias 1(3.3%). The highest percentage of patients studied had two risk factors and of these 71.4% had hemorrhagic stroke. Of the 30 patients, 17(56.6%) had left-brain affection, 6(20%) posterior fossa affection, 4(13.3%) right-brain hemisphere affection and 3(10%) subarachnoid hemorrhage. The QT interval was 328.07 ± 58.24 ms in patients with ischemic stroke vs. 379.77 ± 55.20 ms in patients with hemorrhagic, p = 0.0122. The QTc was 389.68 ± 70.68 ms in ischemic stroke vs. 430.36 ± 62.23 ms in hemorrhagic, p = 0.001. The QTc dispersion 63.43 ± 35.80 ms in hemorrhagic stroke and 44.52 ± 25.13 ms in ischemic stroke, p = 0.04. The QTc dispersion was significantly higher in patients with hemorrhagic stroke in relation to patients with ischemic stroke. 10%(3) patients died: two with hemorrhagic stroke and one with ischemic.

Conclusions: QT, QTc interval and QTc dispersion are increased in the early hours in patients with stroke and without coronary artery disease. By comparison, according to their etiology, we observed that these were higher in bleeding events. These findings could be related to the magnitude, extent and stroke location and may constitute a predictor element of sudden death in these patients.

Keywords

Stroke, QTc dispersion, Cerebral hemorrhage, Cerebral ischemia

Introduction

Cardiovascular and cerebrovascular diseases continue to be the leading cause of death in both men and women of all races worldwide. Cardiovascular disease is the main cause of mortality in Europe, resulting in more than 4 million deaths each year, it accounts for more than half (54%) of all deaths among women and slightly less than half (43%) among men. Overall, 21% of both men and women die of ischaemic heart disease and 12-16% of those are under 65 years of age [1]. According to the Global Burden of Diseases Study [2], 6.26 million deaths occurred in 1990 due to these causes, out

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of a total of 50.65 million deaths in the world. Today, men, women, and children are at risk and 80 percent of the burden in low- and middle-income countries. By 2020 heart disease and stroke will become the leading cause of both death and disability worldwide, with the number of fatalities projected to increase to over 20 million a year and by 2030 to over 24 million a year [3]. Between 1990 and 2020, deaths from non-communicable diseases and injury are expected to rise from 33 million to 58 million annually, with a similar proportional increase in years of life lost. By 2020 It has been projected that cardio-vasculocerebral diseases will cause about 36% of all deaths by the year 2020 [4,5]. Fuster V. [6] presented results of 455 thousand men and 505 thousand women who died of cardiovascular, cerebrovascular disease (CVD) during 1995. Cardiovascular diseases, including ischemic cerebrovascular disease, remain the leading causes of death in the United States and other industrialized countries [6-8]. For about 50 years it has been shown that brain pathologies can cause cardiovascular disorders, which are the cause of severe complications, including the possibility of dying as a result of them [9].

In 1947, Byres E, et al. [10] described 2 patients with subarachnoid hemorrhage (SAH) who presented electrocardiographic changes due to pathological T wave, prolonged QT interval and presence of U wave. Subsequently in 1954, Bruch E, et al. [11] reported 17 patients with electrocardiographic alterations secondary to SAH, intraparenchymal hemorrhage and cerebral infarction. Since then, there are many publications on the subject, developing as such the field of neurocardiology, which includes all those heart diseases that secondarily affect the central nervous system (CNS) and vice versa.

It is clearly demonstrated that hemorrhagic CVD, more frequently than ischemic stroke, generates alterations both in the rhythm and in the morphology of the electrocardiographic tracing, and it differs from one patient to another, depending on the previous cardiovascular state [11].

The physiopathological explanation of these phenomena has been attributed to the autonomic nervous system, sympathetic and parasympathetic. Its simultaneous activation regulated by the hypothalamus seems to be responsible for these events [12]. Other structures involved are the amygdala nucleus, the insular cortex and the nucleus of the solitary tractus.

It has been pointed out that in the first 72 hours of a CVD, whether ischemic or hemorrhagic, severe arrhythmias frequently occur, which are sometimes causes of sudden death, as is the case of Torsades Pointes helical ventricular tachycardia and, that one of the explanations for its genesis is a prolongation of the QT interval and its greater dispersion [13].

On the other hand, the QT interval and the QTc dispersion (QTcd) are an expression of the inhomogeneity of the time of the repolarization of the left ventricle, which, if being prolonged, result in an increase in the vulnerable period and an increase in the susceptibility to malignant arrhythmias, as is the case, for example, in patients with chronic hypocalcemia [14], acute ischemic heart disease [15-19], heart failure [20], hypertensive heart disease [21-23], left ventricular hypertrophy [21,24,25], dilated cardiomyopathy [26], hypertrophic cardiomyopathy [27], diabetes [28,29] and anaerobic exercise athletes [30]. Recent studies have detected an association between this parameter and a higher overall mortality (not only sudden) in patients with all clinical entities described, and even in the general population.

Therefore, the prolongation of the QTcd is recognized as an electrophysiological basis for the generation of serious ventricular arrhythmias [31]. Various experimental studies have highlighted the close relationship between the dispersion of the myocardial repolarization and the development of ventricular arrhythmias [32].

On the other hand it has been concluded that acute brain injury results from an alteration of the autonomic regulation of the cardiovascular system. The increase in QTcd has not yet been demonstrated conclusively in patients with acute CVD and there are very few studies in the literature that study this fact,[33] so we evaluated the QTcdin a group of 30 patients who suffered acute CVD.

Materials and Methods

We selected 30 patients from a total of 44 who were admitted to the emergency room of the Dr. Manuel Núñez Tovar University Hospital due to hemorrhagic or ischemic CVD in a period of five months. Of these, 17 (56.6%) were female and 13 (43.3%) were male. The CVD was classified according to the etiology in ischemic and hemorrhagic. In addition, according to the compromised cerebral topography, they were divided into located in the right cerebral hemisphere, left and posterior fossa. The hemorrhagic ones, in turn, were classified as intraparenchymal and SAH. Patients with antiarrhythmic drugs, atrial fibrillation or atrial flutter type arrhythmias, thoracic or cardiac traumatisms and patients with other neurological pathologies were used as exclusion criteria. In addition, patients whose ECG of admission had poor technical quality and did not allow the quantification of at least 8 leads were excluded.

Clinical variables

The neurological examination of admission considered level of consciousness, orientation, cranial nerve involvement, stem reflexes, osteotendinous reflexes, muscle strength, superficial and deep sensitivity, as well as the language and signs of focalization and pyramidal involvement.

Tomographic variables

All patients underwent computed tomography scan to corroborate the clinical diagnosis of admission and assess etiology, topographic location and extension of the cerebral vascular lesion.The tomographic technique consisted of transversal cuts of 4 mm thick at the level of the base of the skull and 8 mm thick cuts at the cerebral parenchyma level, for which a DRW4 tomograph was used.

Electrocardiographic variables

All patients underwent conventional 12-lead ECG with a Welch Allyn electrocardiograph, Shiller Type AT-1 model

192.03406. The ECG was manually blindly evaluated by an observer who did not know about the patient's clinical data or the etiology of the acute event, and, subsequently, they were measured by another independent observer to evaluate interobserver variability. The electrocardiographic pattern was established according to the following parameters: P wave (duration and voltage), PR segment (duration measured in DII), QRS complexes (duration and voltage), Q wave (pathological when it has a duration equal to or greater than 0.04 seconds and/or depth with respect to the R-wave greater than 25% without altering the electric axis), ST segment (supra-level or under-level greater than 1 mm), presence of U-wave, atrioventricular blocks and duration of the QT interval [34].

Evaluation of the QTc dispersion

The R-R interval was measured from the peak of the R of the previous beat to the peak of the R of the next beat, (Figure 1). The QT interval was measured from the beginning of the QRS until the end of the T wave, when the U wave was present, the QT interval was measured by a tangential method: from the beginning of the QRS to the coincident point between the T wave and wave U, obtained by drawing a line from the vertex of the T wave and another line from the vertex of the U wave, thus defining the end of the T and the beginning of U. The QT was measured in 3 consecutive beats and got the average. The measurements were made on at least 8 leads of the surface of the ECG. The QT was corrected to the heart rate using the Bazzet formula [35]. In this way, a corrected QT value (QTc) was obtained per derivation.

Bazzet formula = QT_m *(ms) /* $\sqrt{}$ *RR (sec)*

Statistic analysis

The data were expressed according to the variables analyzed. For the discrete qualitative ones, they were described in absolute numbers followed by percentages, pie charts, vertical bar graphs. The continuous variables were expressed in measures of central tendency and dispersion, (mean ± standard deviation). Comparisons between the means were analyzed using the Student's t-test, for related samples when the same group of patients was treated, and t-test for independent variables when the variables were compared between different groups, 95% confidence intervals were used and considered significant value of $p < 0.05$.

Results

Clinical characteristics of patients

The distribution according to age, sex, values of blood pressure and heart rate is shown in Table 1. The average age was 65.95 ± 13.97 year, the age range ranged between 32 and 96 years, 53.33% of the cases were older than 65 years, there was a 32-year-old patient who presented a multi-infarct disease (Table 2). On the other hand, female sex 17(56.60%) predominated. The systolic blood pressure (SBP) was 171.12 ± 30.22 mmHg. Diastolic blood pressure (DBP) was 98.38 ± 18.91 mmHg. The heart rate (HR) was 80.05 ± 20.00 beats/min.

Risk factor's

Table 3 shows the risk factors prior to the acute cerebrovascular event, with the highest percentage being arterial hypertension (83.30%), of which patients with hemorrhagic CVD constituted 60%, as expected. Other factors considered were smoking 40%, previous CVD 23.30%, diabetes mellitus 20%, of which 60% had ischemic CVD, ischemic heart disease 13.30%. In a general sense, we can say that only four patients had a history of coronary artery disease. According to the number of associated risk factors, it was observed that 46.66% of the sample presented an association of two risk factors and, of these, 71.40% presented hemorrhagic CVD while 23.33% of the total sample had a risk factor and also with predominance of hemorrhagic disease (Table 4).

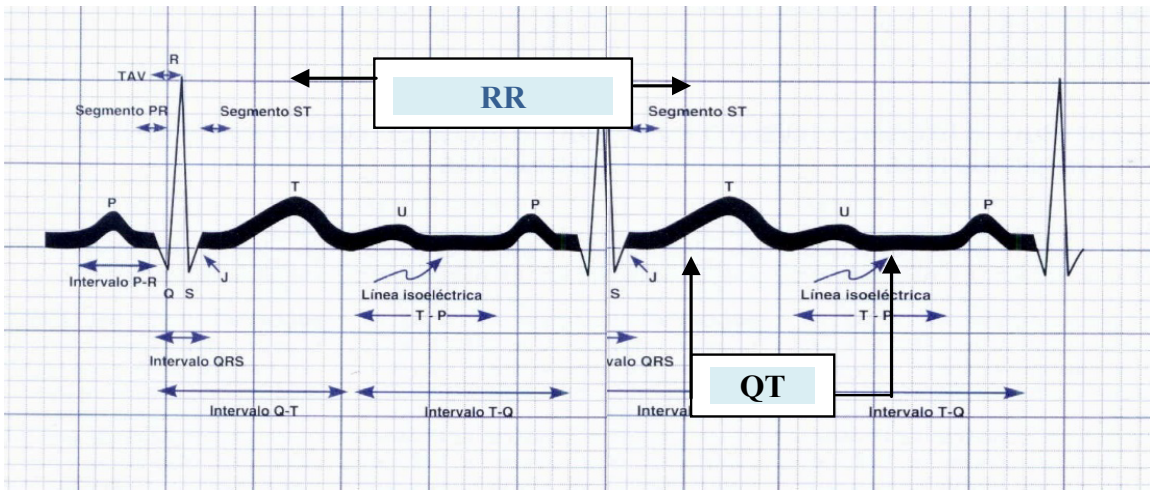


Figure 1: The present figure shows the RR interval, QT interval, U wave of the 12-lead surface EKG.
From the 8 to 12 referrals analyzed, the maximum QT was considered the longest QT and the lowest QT the lowest duration of the average obtained from 24 to 36 measurements.
The QTc was expressed as the difference between the maximum QT less the minimum QT.
QTcd= QTc max - QTc min

Table 1: Population characteristics.

Characteristics	(x ± σ)
Age (años)	65.95 ± 13.97
SBP (mmHg)	171.12 ± 30.22
DBP (mmHg)	98.38 ± 18.91
HR (lat/min)	80.05 ± 20.00

(x ± σ): Arithmetic mean and standard deviation; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; HR: Heart rate.

Table 2: Age group.

Age (years)	N°	%
< 35	1	3.33
35 a 45	1	3.33
45 a 55	5	16.66
55 a 65	7	23.33
65 or more	16	53.33
Total	30	100

Table 3: Risk factors.

	Ischemic		Hemorrhagic	
	N°	%	N°	%
Arterial Hypertension	7	23.3	18	60
Tabaquism	2	6.6	10	33.3
Previous CVD	2	6.6	5	16.6
Diabetes	4	13.3	2	6.6
CAD	3	10	1	3.3
Arrhythmia	1	3.3	0	0

CVD: Cerebrovascular disease; CAD: Coronary artery disease.

Table 4: Number of risk factors.

	Ischemic		Hemorrhagic		Total
Factors	N°	%	N°	%	N°
0	3	100	0	0	3
1	2	28.5	5	72.4	7
2	4	28.5	10	71.4	14
3	0	0	4	100	4
4 or more	2	100	0	0	2

Etiology and topographic location of the lesion

The distribution, according to the type of CVD, 12(40%) ischemic cases and 18(60%) hemorrhagic. Of the 30 patients, 17(56.60%) had involvement in the left cerebral hemisphere, 6 (20%) in the posterior fossa, 4(13.30%) in the right cerebral hemisphere and three cases presented subarachnoid hemorrhage (Table V, Graph I).

QTc interval and QTc dispersion

Regarding the QT and QTc interval, it was evidenced that in the patients with hemorrhagic CVD these parameters were higher in comparison with the ischemic one (379.77 ± 55.20 Vs. 328.07 ± 58.24 ms), p = 0.0122, (430.36 ± 62.23 Vs. 389.68 ± 70.68 ms), p = 0.0001, respectively. The QTcd was also higher in patients with hemorrhagic lesions (63.43 ± 35.80 Vs. 44.52 ± 25.13 ms), p = 0.04, being these, statistically significant comparisons (Table 6 and Graph 2) .

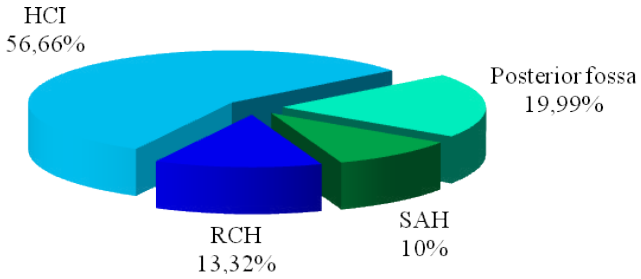
Intrahospital follow-up

The average hospitalization ranged between 5 and 10 days for the ischemic patients and 15 to 20 days for the cases with hemorrhagic CVD, observing that 90% of the patients progressed satisfactorily. Of all the patients with hemorrhagic CVD, one had significant intraparenchymal disease and

Table 5: Compromised territories.

	Ischemic		Hemorrhagic		Total
	N°	%	N°	%	%
RCH	2	6.66	2	6.66	13.32
LCH	6	20	11	36.66	56.66
Posteriorfossa	4	13.33	2	6.66	19.99
SAH	0	0	3	10	10
Total	12	40	18	60	100

RCH: Right cerebral hemisphere; HCI: Left cerebral hemisphere; SAH: Subarachnoid hemorrhage.



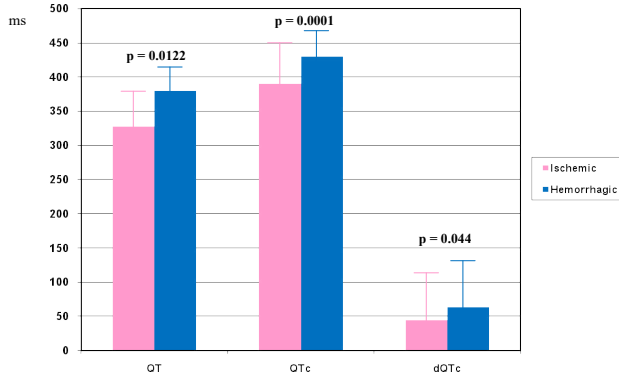
Graphic 1: Compromised territories.

Source: Table 5. RCH: Right cerebral hemisphere; LCH: Left cerebral hemisphere; SAH: Subarachnoid hemorrhage.

Table 6: Electrocardiographic variables.

Ischemic				Hemorrhagic		
	QT*	‡QTc	£QTcd	QT*	‡QTc	£QTcd
(x ± σ)	328.07 ± 58.24	389.68 ± 70.68	44.52 ± 25.13	379.77 ± 55.20	430.36 ± 62.23	63.43 ± 35.80
Max	525	578.83	121.98	448	543.62	166.21
Min	320	341.12	20.13	266.67	350.77	23.40

Values expressed in milliseconds, *p = 0,0122, ‡ p = 0.0001, £p = 0.04



Graphic 2: Electrocardiographic variables.

Source: Table 6.

therefore underwent surgery to drain the hematoma, and had good outcome. 3 (10%) patients died, two with hemorrhagic CVD and one with ischemic CVD, the latter presented extensive involvement of the left cerebral hemisphere.

Discussions

The development of neurocardiology allows the understanding of what primary pathological events of the CNS can affect the cardiovascular level. These facts have been known for approximately 60 years [11]. As the heart has an important and pronounced autonomic innervation, it is to be expected that acute disturbances of the CNS might result in a wide spectrum of cardiac functional disorders [36]. Since then, there have been multiple studies showing that CVDs also produce disorders in the surface ECG.

Cardiac arrhythmias may be associated with adverse outcome: 80% mortality in patients with acute stroke due to ventricular tachyarrhythmias, compared with 23% in those without arrhythmias [37]. Clearly, these alterations are more frequent in hemorrhagic than in ischemic CVD. Other authors suggest that between 5-20% of cerebral infarcts present these alterations [12].

Considerable evidence for the role of the cortex in the regulation of cardiac rate and rhythm exists from historial sources, contemporary clinical observation and animal experimentation. Here is a large body of evidence indicating that insular involvement may adversely affect cardiac prognosis after stroke [37]. Much of this was forgotten with the advent of World War II. In the aftermath, single case reports of intriguing ECG repolarization changes after SAH were reported: inverted T waves (often tall, symmetrical downward peaking) and prolonged QTc interval with ST elevation or depression [37].

Collectively these data strongly indicate that the brain has a major influence on cardiac structure and function and that this is likely mediated through alterations in patterning of sympathovagal relationships.

Age groups

Authors as Kawasaki, et al. [12] studied a total of 122 patients met the criteria (56 males, 66 females; mean age: 58.5 ± 13.6 years), The survivors (80 patients) were younger than the nonsurvivors (40 patients) (54.7 ± 11.3 vs. 65.6 ± 15.8 years, $p < 0.0001$), Findings similar to ours where three patients died, all of the older group.

The study conducted by Lazar J, et al. [33] found that the average age was 72 ± 13 years old, whereas in this study the average age was lower, being 65.95 ± 13.97 years old, noticing a higher volume of patients older than 65 years old.

Risk factors

A risk factor for stroke is a characteristic in an individual that indicates that the individual has an increased risk of stroke compared with an individual without that characteristic.

Risk factors for stroke are usually divided into non-modifiable (age, sex, ethnicity, low weight at birth, inherited diseases) and modifiable (hypertension, diabetes mellitus, heart diseases, smoking, dyslipidemia, alcohol abuse, obesity, metabolic syndrome, use of oral contraceptive drugs, hormone treatment in postmenopausal women, clinically silent carotid stenosis, peripheral artery disease, drug abuse, migraine, and other). Hypertension, Cigarette smoking, diabetes mellitus and ischemic heart disease, are probably also causal risk factors for ischemic stroke because epidemiological case-control and cohort studies have shown that these characteristics are significantly associated with an increased risk of stroke; moreover, the association is strong, consistent among studies, biologically plausible, and independent of other factors that were measured and analyzed.

In the study published by ArboixA, [38] according to data of 2704 patients with first-ever ischemic stroke collected from the SagratCor of Barcelona Stroke Registry, was found to be hypertension was the main risk factor in the different age groups, 48-61% followed by diabetes mellitus 18-27%, Dyslipidemia 9-26% and ischemic heart disease 9-18%. In our series, hypertension was also the predominant risk factor, followed by tabaquism, previous CVD and diabetes mellitus, findings similar to those of the other authors [38]. On the other hand, we value the association of several risk factors, finding that the most frequent was the presence of two risk factors, this variable has been little studied in previous studies.

Hypertension: In agreement with previous studies,[39] our results show that arterial hypertension was the most important and frequent risk factor for stroke, and a more potent risk factor for intracerebral haemorrhagic stroke than for ischaemic stroke. We used the values measured in the emergency room at the time of admission with the acute picture, in addition those patients who had a previous diagnosis of hypertension were considered; while authors [40] used the mean of three blood pressure measurements in cases in an effort to keep these competing biases to a minimum. This method might overestimate the importance of raised blood pressure, although it was used a high cutpoint for blood pressure of 160/90 mm Hg. However, both approaches suggest that blood pressure is the most important risk factor for stroke, and more important than other objectively measured risk factors (ie, lipids and glucose).The researchers (INTERSTROKE) found that a history of hypertension was the strongest risk factor for stroke, with nearly a threefold increased risk (OR 2.64, 95% CI 2.26 to 3.08), and the association was stronger for hemorrhagic stroke [40].

Cigarette smoking: Is an independent predictor of cerebrovascular disease in both men and women [41]. Smokers have a relative risk of ischemic stroke of 1.92 times higher as compared to non-smokers. Smoking increases the risk of thrombus formation in narrow arterial vessels and contribute to enhance atherosclerotic plaque burden. Also, smoking increases blood viscosity, fibrinogen and platelet aggregation, and decreases high-density lipoprotein cholesterol, which causes direct damage to endothelium and an increase in blood pressure [42]. In our study, one third of the patients presented this risk factor, a common finding in patients with a brain event.

Previous CVD: Inherited Susceptibility: A family history of stroke is a risk factor for ischemic stroke, but the mechanisms remain uncertain. Inherited susceptibility to ischemic stroke may result from the direct effect of a single gene on the risk of stroke at a young age (before environmental and behavioral factors have had time to modify the phenotype), interactions of a gene with environmental or behavioral factors, an additive effect of several genes (agene-dose effect), or synergistic coeffects of several genes [43]. A classical mendelian pattern of inheritance of single-gene disorders is rare, accounting for1% of cases of ischemicstroke [43].

Diabetes mellitus: Is an independent risk factor of ischemic stroke of atherothrombotic cause. The influence of diabetes upon increasing the stroke risk is higher in women than in men. Diabetes is the main risk factor following hypertension of cerebral small vessel disease and has been identified as a significant independent variable of symptomatic recurrence in patients with first ever cerebral infarction of the lacunar type [38].

Compromised territories

In most studies it has been reported that acute ischemic CVD is the most frequent, however, it differs from our results, where hemorrhagic was the one that predominated. It should be noted that a significant percentage of patients admitted with atrial fibrillation and atrial flutter were excluded, who mostly presented ischemic CVD [12].

Electrocardiographic variables

The lesions of the CNS frequently lead to disturbance of cardiovascular system and other autonomic functions. The manifestations of such type of autonomic dysregulation are loss of heart rate variability and various ECG changes. The sympathetic tone is increased in acute ischemic stroke, which leads to elevated levels of circulating catecholamines and responsible for cardiac complications including arrhythmias, ECG changes, and ischemic heart damage, and associated with the poor prognosis of the disease [44,45].

In such a way that the relation between ECG abnormalities and prognosis has been extensively studied in patients with SAH, with varying results. Authors as Lazar J, et al. [33] found increased QTcdon admission ECG in patients presenting with acute neurological events, this was significantly related to hospital mortality and poor functional outcome on discharge. There was significantly higher value of QTcdin patients with ICH as compared to infarct and TIA (70 ± 15 ms vs. 53 ± 27 ms vs. 48 ± 31 ms, respectively), among studied 140 patients of CVA and TIA. The increasing QTcd was associated with lower functional outcomes on all three scales and with higher mortality. Several studies have evaluated the relationship between the sympathetic activity and QT dispersion. Our study was aimed to find out the relation of QT and QTcd with stroke subtype and its prognostic importance [46]. Wong KY [47] reported that after adjusting for overt cardiac disease and traditional ischemic risk factors, stroke patients with QTc prolongation in lead V6 had a 2.8 relative risk of cardiac death. If the QTc exceeded 480 ms then the specificity was 94% for cardiac death prediction within five years. Eckardt [48] showed that insularstrokes were particularly associated with QT dispersion lengthening compared with those in other locations. Collectively, these data indicate that significant cardiac arrhythmogenesis can occur following stroke. This is most pronounced after SAH, but may also accompany intracerebral hemorrhage and ischemia. In many reported series, precision is reduced by failure to account for concomitant ischemic cardiacdisorders as a confounding variable, and by the use of ECG rather than Holter data. Additionally, most studies are of short duration, performed in the acute phase and do not investigate the longer-term cardiovascular consequences of the lesion. It is this latter which may prove to be of importance in determining survival, and, as yet, definitive data on this point are lacking.

QTd According to lesion localization

This study showed considerable variability in the measurement of QTcd in the ECG of admission in patients admitted for acute CVD. The increase in QTcd was greater in the group of patients with hemorrhagic CVD compared to the group with ischemic lesion, findings concordant with other authors [31,33]. Elements that could be explained by the severity and extension of the lesion. The weight of the evidence suggests that hemorrhagic strokes have higher QTcd values compared to ischemic strokes [33]. The physiopathological explanation of these phenomena has been attributed to the autonomic nervous system, sympathetic and parasympathetic, its simultaneous activation regulated by the hypothalamus seems to be responsible for these events [11,12] in such a way that the association of ECG changes with SAH has been attributed to the adverse effects of elevated concentrations of catecholamines, because the hemorrhage commonly involves the basilar cisterns, which are in close proximity to the hypothalamus, leading to excessive secretion of catecholamines.

It is important to note that serious arrhythmias occur in the initial period, the first 72 hours, of having started the hemorrhagic event and some of them are cause of sudden death as is the case of torsades de pointes type ventricular tachycardia [49] it is known that prolonged QTc reflects cardiac repolarization prolongation and/or increased repolarization inhomogenity known to be associated with an increased risk of arrhythmias in multiple clinical settings [45]. Between 50 and 100% of patients experience cardiac rhythm disturbances during the acute phase of SAH. The majority of these abnormalities are benign, with sinus tachycardia, sinus bradycardia, and premature atrial and ventricular beats being the most common [50]. Only 1-4% of patients experience a clinically significant arrhythmia, such as ventricular tachycardia or atrial tachyarrhythmias. We highlight that we excluded all patients who presented atrial fibrillation or atrial flutter, in such a way that patients who could have triggered a complex ventricular arrhythmia derived from atrial fibrillation were not considered.

On the other hand Myers, et al. [32] found significantly higher levels of plasma norepinephrine, in patients with stroke, and explained the cardiac abnormalities in cerebral infarction by increased sympathetic activity. Direct evidence

linking reduced parasympathetic control and increased QTcdis lacking despite reduced parasympathetic controlled heart rate variability in patients with ischemic stroke.

In 1954, Burch E, et al. [11] identified an ECG pattern characteristic of intracerebral hemorrhages (existence of a QT > 440 milliseconds, presence of U wave, ST and T wave alterations) that we found in only 5% of our casuistry. This could allows us to explain the fact that certain topographic encephalic areas are closely related to these disorders, which justifies the fact that according to the size of the CVD, they may present with serious complications and others of larger size, but in non-compromising topographic areas are not accompanied by these events. There are studies that suggest higher QTcd in right-sided cerebral lesions versus left-sided cerebral lesions [51]. Randell, et al. [52] reported that patients with subarachnoid hemorrhage have increased QTcd compared with controls; they also observed episodes of cardiac arrhythmias in these patients. However, it is likely these studies included patients who already had cardiac disease. Considering the rate of concomitant cardiac disease in patients with acute cerebrovascular events, this raises the possibility of the effect of preexisting heart disease on QTcd.

In our study, patients were selected concurrently and prospectively, to avoid any history or signs of coronary artery disease, therefore, the increase in QTcd, such that our patients are likely to be the result of the cerebrovascular event itself, showing that QTcd increases in the acute phase, In addition, only seven patients had previous heart disease.

Other electrocardiographic alterations

On the other hand, the ECG findings related to higher mortality were the flat or inverted T wave and the prolonged QT interval. It is important to point out that two patients who suffered hemorrhagic CVD presented ECG alterations in the whole, greater prolongation of the QT interval; It should be noted that these patients were the oldest, with two and three associated risk factors. The poor prognosis was also related to patients who had greater neurological deterioration. It is considered that these alterations are a reflection of the serious imbalance between the sympathetic and parasympathetic system due to direct or indirect alterations of the hypothalamus and the brainstem with abrupt and exaggerated release of noradrenaline [53].

Limitations

This study is limited by the relatively small number of patients from a single institution, the possible cross-sectional design; patients were followed only during their hospitalization.

Conclusions

The female patients were the most complicated. The greatest number of patients presented complications, even without previous cardiovascular history. Sinus tachycardia and ventricular premature beats were the most frequent rhythm disorders. The flat or inverted T wave was the most frequent morphological disorder.There was greater QT dispersion in patients with hemorrhagic CVD. Future studies with a larger sample size are needed to help clarify the relationship of size, location and extent of acute cerebrovascular disease with the dispersion of the QT interval, and provide possible pathophysiological explanations of this phenomenon.

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