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Electrocardiographic abnormalities in hospitalized elderly patients

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ARTICLE INFORMATION

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Acronyms
AF: atrial fibrillation
ECG: electrocardiogram
LBBB: left bundle branch block
LVH: left ventricular hypertrophy
RBBB: right bundle branch block

ABSTRACT

Introduction: Aging causes an increase in cardiovascular morbidity that can be reflected in the electrocardiogram, but not all older adults' subpopulations have been systematically studied.
Objectives: To determine the main electrocardiographic alterations that occur in elderly patients with cardiovascular morbidities.
Method: Cross-sectional descriptive study in 148 patients ≥ 60 years, with cardiovascular morbidities, admitted to the Internal Medicine service of the "Hospital Celestino Hernández Robau" in Villa Clara. Electrocardiographic variables suggestive of cardiac involvement were identified.
Results: The average age was 77.4 ± 8.2 years. Atrial fibrillation was seen in 16.9% of cases. There were alterations of ventricular repolarization in 39.3% of cases, as well as left/right bundle branch block in 14.4% and 5.4% respectively. A 24.7% of patients presented left atrial abnormality and 17.8% QT prolongation. The highest number of cases with electric left ventricular hypertrophy was detected with the R aVL criteria (9 patients [10.2%]).
Conclusions: The most frequent rhythm disorder was atrial fibrillation. Alterations of ventricular repolarization prevailed over those of depolarization with no association with sex or skin color. There was a considerable number of cases with left atrial abnormality, left ventricular hypertrophy and long QT.
Keywords: Older adults, Electrocardiography, Morbidity, Cardiovascular diseases

Alteraciones electrocardiográficas en pacientes adultos mayores hospitalizados

RESUMEN

Introducción: Como parte del envejecimiento ocurre un incremento de la morbilidad cardiovascular que puede reflejarse en el electrocardiograma, pero no todas las subpoblaciones de adultos mayores han sido estudiadas sistemáticamente.
Objetivo: Determinar las principales alteraciones electrocardiográficas que acontecen en pacientes adultos mayores con morbilidades cardiovasculares.
Método: Estudio descriptivo, transversal en 148 pacientes ≥ 60 años, con morbilidades cardiovasculares, ingresados en el servicio de Medicina Interna del Hospital Celestino Hernández Robau de Villa Clara. Se determinaron variables electrocardiográficas sugerentes de afectación cardíaca.
Resultados: La edad promedio fue 77,4 ± 8,2 años. La fibrilación auricular fue observada en 16,9% de los casos. Existieron alteraciones de la repolarización ventricular en 39,3% de los casos, así como bloqueo de rama izquierda o derecha en 14,4% y 5,4%, respectivamente. Un 24,7% de los pacientes presentaron anormali-

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dad auricular izquierda y 17,8%, prolongación del QT. El mayor número de casos con hipertrofia ventricular izquierda eléctrica se detectó con el criterio R aVL (9 pacientes [10,2%]).

Conclusiones: El trastorno del ritmo más frecuente fue la fibrilación auricular. Las alteraciones de la repolarización ventricular prevalecieron sobre las de la despolarización, sin asociación con el sexo o color de piel. El número de casos con anormalidad auricular izquierda, hipertrofia ventricular izquierda y QT largo fue considerable.

Palabras clave: Adultos mayores, Electrocardiografía, Morbilidad, Enfermedades cardiovasculares

INTRODUCTION

Population aging is one of the demographic characteristics of the 21st century. This process is necessarily accompanied by an increase in the prevalence of cardiovascular diseases that may have expression on the electrocardiogram (ECG).

A prevalence of 1.6% of undiagnosed atrial fibrillation (AF) has been found in patients over 65 years of age[2], and can reach up to 10% in people over 80 years[3]. Sinus dysfunction has an estimated prevalence of 1/600 people over 65 in the United States[3] and intraventricular conduction disorders are not uncommon.

Diseases such as arterial hypertension, ischemic heart disease and heart valve diseases, with or without heart failure, are likely to contribute to the development of ventricular repolarization disorders, including prolongation of the corrected QT (cQT) interval, which is a known predictor of sudden cardiac death and it is enhanced with the use of certain drugs commonly used in these ages[4].

Despite this well-established knowledge, electrocardiographic analysis series in elderly patients under hospital admission remain poorly researched. Therefore, we aim to determine the main electrocardiographic alterations that occur in elderly patients with cardiovascular morbidities, admitted to an Internal Medicine service.

METHOD

A descriptive cross-sectional study was carried out in elderly patients with cardiovascular morbidity, admitted for any reason in the Department of Internal Medicine at the *"Hospital Celestino Hernández Robau"* in Villa Clara province, in the period between April 2016 and March 2017.

The cases were selected in a non-probabilistic way and a sample of 148 patients who met the criteria required for the study was selected: elderly patients (≥60 years) with cardiovascular morbidity and a clinical history containing the data required for this study.

Patients who died during admission or those with a hospital stay of less than 24 hours were excluded from the trials.

Variables

We collected general variables such as: age, sex, skin color, origin (urban or rural) and days of hospital stay, as well as variables obtained from the ECG. The latter were measured using the ECGs available in the medical record, provided they had sufficient technical quality for their measurement, and took into account the characteristics of each variable. No voltage indices were measured in cases with branch blockages or pacemaker patterns.

The electrocardiographic variables analyzed were:

- Rhythm: Refers to the dominant rhythm found in the ECG and includes normal or typical sinus rhythm, arrhythmias such as AF, atrial flutter, focal atrial tachycardia, multifocal atrial tachycardia and pacemaker rhythm.
- Voltage indices for the detection of left ventricular hypertrophy (LVH):
  - R in aVL: Amplitude of the R wave of the QRS complex, measured (in millimeters) in the aVL lead. It is considered positive for LVH if>11 mm.
  - Sokolow index: It is the sum of the deepest S wave in leads V_1 or V_2, plus the amplitude of the highest value R wave recorded in V_5 or V_6. It is expressed in millimeters and is considered positive for LVH when it is>35 mm.
  - Sokolow-Lyon Index: Same as above (Sokolow

Index), but it is necessary to determine the R wave amplitude in aVL. It is expressed in millimeters and is considered positive for LVH when it is>35 mm and the R wave in aVL is>11 mm.

- Cornell Index: Sum of R wave in aVL and S wave in V_3. It is expressed in millimeters and is considered positive for LVH if>28 mm in men or>20 mm in women.

- Intraventricular conduction status: Determination of the normal or pathological way in which the electrical impulse is transmitted through the ventricles by electrocardiography. It was classified as normal or with complete/incomplete blockage of the left (LBBB) or right (RBBB) bundle branch.
- Ventricular repolarization status: It was evaluated according to whether specific or non-specific primary T-wave alterations were present or not. Alterations due to LVH patterns, branch blockages and pacemaker rhythm were excluded from this analysis.
- cQT: It was another way of analyzing ventricular repolarization. It was obtained by applying the Bazzet formula in lead V_5, where:

$$cQT = \frac{QT\ measured}{\sqrt{R-R\ interval}}$$

It is expressed in seconds and is considered prolonged if>0.44 seconds in men and>0.46 seconds in women.

- Left atrial abnormality: P-wave electrocardiographic disorder that translates growth, hypertrophy or interatrial conduction abnormalities. It was considered present if the P wave in the D_{II} lead was≥0.12 seconds.
- Right atrial abnormality: P-wave electrocardiographic disorder that translates growth, hypertrophy and/or intra-atrial conduction disorder in the right atrium. It was considered present if the P wave in the D_{II} lead>0.25 millivolts (2½ mm).
- PR interval: Period of time from the beginning of the inscription of the P wave until the moment at which the Q or R wave of the ECG begins. The derivation in which this measure was the greatest of all was used. It is expressed in seconds and was considered prolonged if PR>0.20 seconds.

Statistical processing

The data collected in this study were stored and processed using the SPSS version 21.0 program. Bar charts were prepared using the EXCEL program. Qualitative data were presented in absolute and relative frequencies, while quantitative variables are shown as mean±standard deviation.

To determine the possible association between qualitative variables, Chi square and Fisher's exact tests were used, according to the established criteria, and the value of their respective statistician was shown as a result of the application of these tests. According to the p value, the level of statistical significance was classified as significant ($p<0.05$) or not significant ($p\geq0.05$).

The data were collected from the medical records available in the archive department of the "Celestino Hernández Robau" Hospital in Santa Clara, Villa Clara, Cuba.

Table 1. General characterization of the patients studied (n=148).

General variables	Nº	%
Age (years, mean±SD)	77.4 ± 8.2	
Sex*		
Female	70	47.3
Male	78	52.7
Skin color		
White	127	85.8
Not white	21	14.2
Origin**		
Urban	75	50.7
Rural	73	49.3
Hospital stay (days, mean±SD)	8.7 ± 6.3	

Source: Medical records
*p>0.05
**p>0.05

RESULTS

The average age was 77.4±8.2 years. There were no significant differences in gender (female: 47.3% and male: 52.7%; p>0.05), or place of origin (urban: 50.7% and rural: 49.3%, p>0.05). White skin widely predominated over non-white (85.8% vs. 14.2%). In our series, we found that the patients remained an average of 8.7 days on admission (**Table 1**).

Atrial fibrillation was present in 20 patients (16.9%) and a pacemaker rhythm was detected in 7 (5.7%); other rhythms were uncommon and pres-

ented in isolated cases (**Figure 1**).

Intraventricular conduction status is shown in **table 2**. Of 118 cases with available ECG, 111 were included in this table, since 7 were excluded with wide QRS due to pacemaker stimulation. In most cases (80.2% [89 patients]) synchronous ventricular depolarization (narrow QRS) prevailed, and complete/incomplete, left/right branch blockages were observed in 16 (14.4%) and 6 (5.4%) patients respectively. In our series there was no significant statistical association between intraventricular conduction disorders and sex (LBBB [p>0.05] and RBBB [p>0.05]), or skin color (LBBB [p>0.05] and RBBB [p>0.05]). Neither was narrow QRS with these same variables (p>0.05 in both cases).

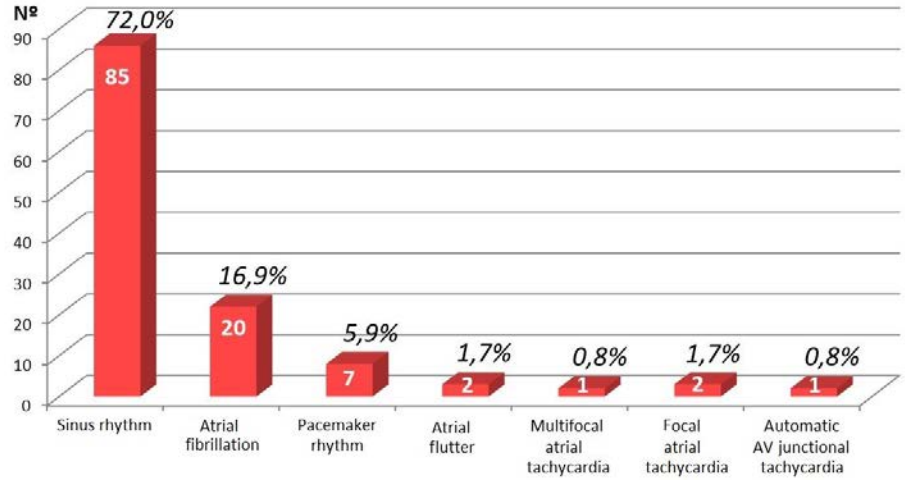

Figure 1. Types of rhythm observed in patients with available electrocardiogram (n=118). AV, atrioventricular.

Table 3 shows ventricular repolarization status of the 84 patients in our series who had a 12-lead ECG (which is necessary for a complete characterization of this parameter because of its topographic

Table 2. Intraventricular conduction status according to sex and skin color.

ECG findings	Sex*				Skin color**				Total (n=111)	
	Male (n=52)		Female (n=59)		White (n=95)		Non-white (n=16)			
	N°	%	N°	%	N°	%	N°	%	N°	%
Narrow QRS complex	42	80.8	47	79.7	75	78.9	14	87.5	89	80.2
Left bundle branch block	7	13.5	9	15.2	14	14.7	2	12.5	16	14.4
Right bundle branch block	3	5.7	3	5.1	6	6.3	0	0	6	5.4

Source: Electrocardiogram (ECG)
*Fisher's exact test = 1.309; p>0.05
**Fisher's exact test = 0.976; p>0.05

Table 3. Ventricular repolarization status according to sex and skin color.

Ventricular repolarization	Sex*				Skin color**				Total (n=84)	
	Male (n=37)		Female (n=47)		White (n=70)		Non-white (n=14)			
	N°	%	N°	%	N°	%	N°	%	N°	%
Normal	22	59.5	29	61.7	43	61.4	8	57.1	51	60.7
Abnormal	15	40.5	18	38.3	27	38.6	6	42.9	33	39.3

Source: Electrocardiogram
*$\chi 2=0.044$; p>0.05
**$\chi 2=0.090$; p>0.05

nature), and who were eligible for the analysis of this variable. Ventricular repolarization disorders were seen in 33 patients (39.3%) and had no significant statistical association with sex or skin color.

Figure 2 shows that the voltage criterion that most LVH cases detected was the height of the R wave in aVL (9 cases [10.2%]), while the lowest detection was seen when using the Sokolow-Lyon index (2 cases [2.3%]). Left atrial abnormality was found in 24.7% of cases, while right atrial abnormality was found in 5.9% of patients, and prolonged cQT was present in 17.8% of patients.

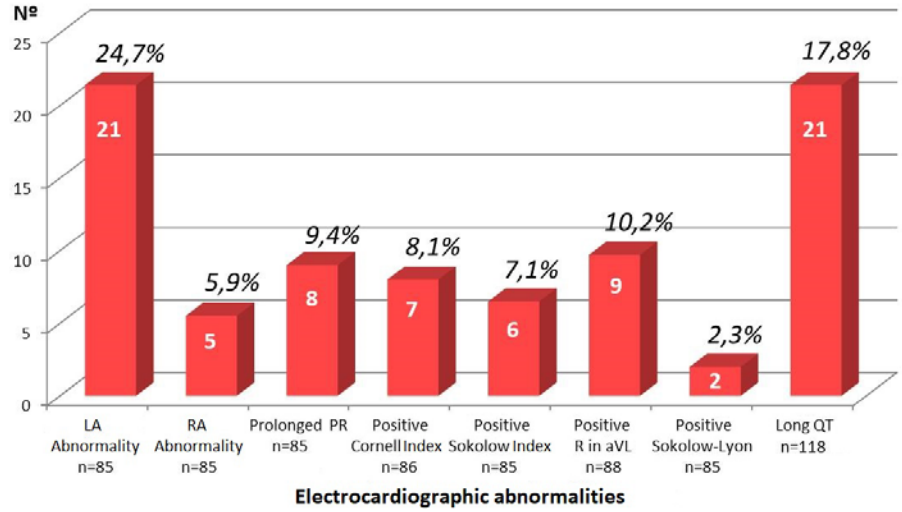

Figure 2. Prevalence of atrial abnormalities, left ventricular hypertrophy and long QT in patients with available electrocardiogram. Only the data of the patients where each variable could be analyzed are shown.
RA, right atrium; LA, left atrium.

DISCUSSION

The average age observed in the study reflects the aging of the population analyzed which can be attributed to the work design intentionally focused on these ages. In Cuba, according to recent data, people with age≥60 years represent 20.1% of the total population and particularly in Villa Clara, constitute 23.3% (183083 people)[5]. Regardless of age groups, sex is equally distributed in our country (49.7% male and 50.3% female); when only people≥60 years are taken into account, and specifically from Santa Clara, men constitute 47.4% (86721 people) and women 52.6% (96362 people)[5]. The above does not differ from our results since the sexes presence in both our research and the national data was very similar.

Urbanization reaches up to 77% of the Cuban population[5], which contrasts with the similar origin behavior (urban and rural) of the patients in this series. The definition of urbanity or rural location and the form of selection for the sample studied, added to the fact that this hospital receives patients from a small sector of Santa Clara city and four municipalities, may explain this result.

National hospital stay in the Departments of Internal Medicine in 2015, 2016 and 2017 was 7; 7.5 and 7.2 days, respectively, regardless of age or associated comorbidities[5,6]. The patients in our investigation remained approximately 1-1.5 more days, but this result is not significantly far from what was reported nation-wide. Moreover, as all of these patients had cardiovascular diseases and age≥60 years, some overdraft in hospital stay is expected with respect to the national pattern; which coincides with the results of Singera *et al*[7], who found an average hospital stay of 11.9 days in 421 nonagenarians admitted to a Department of Internal Medicine, and suggested that age plays a significant role in assessing this parameter. Similar trends were observed by Merengoni *et al*[8], who confirm that average hospital stay increases in older patients compared to younger ones. There is no doubt that, over the years, they suffer more comorbidities and disability.

As age increases the probability of permanently maintaining sinus rhythm decreases. Devkota *et al*[9], after studying 157 patients admitted with heart failure, found a prevalence of atrial fibrillation and flutter of 14.6% and 13.4%, respectively, which coincides with our results as we detected that 16.9% of the cases presented AF; however, atrial flutter was observed only in 1.3% of patients, which is significantly lower considering the global behavior of this arrhythmia. Recent data indicate that the average age of AF presentation in the United States is 66.8 years for men and 74.6 for women, and that there has been an increase in the incidence of this arrhythmia of approximately 5% a year in patients≥65 years who

are Medicare users[10].

Atrial fibrillation has a high prevalence in the elderly; in patients≥80 years it may reach up to 23.5% though[2]. Hence current guidelines recommend routine pulse taking from 65 years up as part of the different research which must be carried out from primary health level[11]. The admission rate due to AF in both sexes greatly varies according to age with 32.5 patients per 100.000 inhabitants in men between 15-45 years of age, up to 1275.8 in those over 85 years, and these figures are significantly lower among women between 15-45 years (5.4/100.000 inhabitants), but increase in the group of 85 years and older (1323.4/100.000 inhabitants)[2]. Atrial flutter frequently coexists with AF and its prevalence is expected to consistently increase with the growth of older population[12], although it did not predominate in our study, as previously mentioned.

The appearance of various rhythm disorders encompasses the two opposite sides of the arrhythmic spectrum, namely, bradyarrhythmias and tachyarrhythmias. The first, unspecified between sinus dysfunction or atrioventricular blocks, were indirectly found in our study through the detection of a pacemaker rhythm, but they are less frequent than rapid arrhythmias. Sinus dysfunction is currently one of the main causes of pacemaker implantation (30-50% of cases), apart from atrioventricular block[13]. An increase in the number of annual cases in the United States is expected, ranging from 78.000 in 2012 to 172.000 by 2060[14]. The complete atrioventricular block is mainly observed in elderly patients with structural heart disease (incidence of 1/100.000 people/year), as well as the Mobitz II type that occurs in approximately 2% of people≥70 years[15].

Other arrhythmias such as multifocal atrial tachycardia, which is typically associated with respiratory failure, focal atrial tachycardia and automatic atrioventricular junctional tachycardia, were only observed in one case and this could be related to the fact that they are arrhythmias of lower prevalence than those mentioned above. In addition, the reviewed ECGs were not necessarily recorded at times when their occurrence could have been most likely.

The prevalence of LBBB is 0.4% at 50 years and rises to 6.7% at 80 years[16-19]. In a study with 69186 patients who went to a medical center for routine examinations, LBBB had a prevalence of 0.08%[20], much lower than that reported by other authors. However, this was attributed to the characteristics of the analyzed population which had a low cardiovascular risk. On their part, Kawabata-Yoshihara *et al*[21], in 1524 patients≥65 years, participants in an electrocardiographic survey carried out in Sao Paulo, LBBB was observed in 3.1% of the analyzed population with very similar prevalences when comparing men (3.1%) and women (3.8%); which coincides with our results, where this disorder had no association with sex, although with a higher prevalence, which undoubtedly must be attributed to the fact that a population at high risk was studied due to age, comorbidities and the very condition of being admitted, which adds different degrees of worsening to the baseline condition of these cases.

RBBB is an intraventricular conduction disorder in which normal electrical activity in the His-Purkinje system is interrupted or delayed, an issue that delays depolarization of the right ventricle. It has a prevalence in the general population of 0.3-1.3%, with a higher proportion of cases when the disorder occurs in its incomplete form with respect to the complete one[20], and can be found in an incidental ECG as part of routine tests. Sometimes RBBB translates a hidden or symptomatic heart disease, although it also appears in lung diseases (pulmonary embolism, *cor pulmonale*).

Previous studies have been contradictory in defining the prognostic significance of RBBB both in patients with heart disease and in the general population. Xiong *et al*[22] published the results of a meta-analysis that gathered 201437 participants, where they demonstrated that complete RBBB is associated with an increased risk of mortality both in general population and in patients with heart disease. In contrast, O'Neil *et al*[23] found in 6398 patients with incomplete and complete RBBB that the RSR pattern was a benign finding, without association with mortality or cardiovascular disease in adults without clinical manifestation of heart disease. The higher prevalence of RBBB in our research is due to the characteristics of the population analyzed as is the case with LBBB.

A high number of cases showed ventricular repolarization involvement, which suggests that it is a more sensitive marker of cardiovascular involvement than intraventricular depolarization disorders. The REGARDS study that evaluated electrocardiographic abnormalities in a sample of 20962 American people determined that the most frequent were ventricular repolarization disorders, which were more prevalent in adults older than 65 years, without differences between black and white people[24], a prevalence that may vary depending on whether the al-

terations are greater (specific) or minor (nonspecific). On the other hand, Molaschi *et al*[25], after analyzing 340 elderly patients admitted with non-cardiovascular diseases, observed that the prevalence of major ST-T alterations ranged between 6.3-13% and reached 23.8% when the subgroup of patients over 80 years was exclusively analyzed. In our series, the prevalences were much higher than those of the reviewed works, but specific and nonspecific anomalies of ventricular repolarization were taken into account, which may partly explain this finding.

The existence of a history of coronary artery disease or arterial hypertension markedly increases the prevalence of various electrocardiographic abnormalities (including ST-T alterations) in people≥65 years[26]. The association between classic risk factors and isolated and nonspecific ST-T anomalies was also evidenced in the review by Healy and Lloyd-Jones[27]. Nonspecific ST segment and T wave abnormalities predict cardiovascular and global mortality, even in patients without coronary heart disease or known risk factors, according to the results of the NHANES III study in adults between 40-90 years[28], which emphasizes the importance of their detection especially in the elderly, where all data indicate that they have a higher frequency. Men are more likely to have a higher prevalence of ventricular repolarization disorders[26], but in our research this behavior was only discrete and lacked statistical significance, which suggests that other variables such as: age, comorbidities, hospital admission and polypharmacy could be influencing this result.

A substantial number of patients presented left atrial abnormality, which is the preferred term over that of left atrial growth, due to the clinical significance of this variable. Studies of electrocardiographic-echocardiographic and autopsy correlation have shown that P wave can be abnormally wide due to atrial characteristics other than dilation, for example hypertrophy of its walls without dilation, increase in intra-atrial pressure and interatrial conduction disorders[17,29]. The clinical importance in the detection of this electrical alteration is that it is associated with more severe ventricular dysfunction in patients with ischemic heart disease and with more severe valve lesions in patients with mitral or aortic valve disease[29]. In addition, these patients have a higher than normal incidence of atrial tachyarrhythmias such as AF[29-31].

The presence of an abnormally high P wave in lower leads has been found in up to 20% of patients with chronic obstructive pulmonary disease[32], but it has little correlation with the right atrial size, so the term "growth" should also be avoided. In our series, this type of lung disease was only present in 8.8% of cases and may explain, in part, the low prevalence of this electrical anomaly. On the other hand, some dynamic factors have been better correlated with this parameter, such as the degree of pulmonary hyperinflation, oxygen saturation level, sympathetic stimulation and bronchospasm degree; so, depending on the clinical state and the underlying diseases presented by the patient, the presence of an abnormally high P wave may be more likely or not[17].

The detection of LVH by the ECG varies according to the criteria used for its detection. When using the best indices, the sensitivity ranges from 10-50%, depending on whether general or hypertensive population is studied[29]. In a post-mortem study where the chamber dissection technique was applied in 185 cases with LVH, the Sokolow index detected 22% and the R criterion in aVL>11 mm, 17%[33]. The aVL lead has been used as a single or combined criterion (Cornell) in the detection of LVH due to the increase in voltage that occurs when the electric axis deviates to the left. The aVL criterion was that with highest number of cases detected in our investigation, although another recent study obtained a sensitivity of 20% with a significant lack of agreement in the detection of LVH by echocardiography[34]; in another research it was<10%[35]. Sensitivity of the Cornell index was calculated at 62% by Peguero *et al* [34], but it showed a very low value (<20%) in the study by Lu *et al*[35], both for both sexes and for ages over and under 60 years.

A study carried out in Taiwan that included 539 men without arterial hypertension concluded that the Cornell index is more sensitive and specific than that of Sokolw-Lyon and, moreover, that it correlates better with the left ventricular mass index obtained by echocardiography[36]. When the R criterion in aVL is added to the Sokolow index, the specificity increases, although this reduces sensitivity. In our study, the Sokolow-Lyon index had the least detection of LVH, in correspondence with the aforementioned. However, Mbaye *et al*[37], when investigating 515 Senegalese hypertensive patients, found that this index detected a greater number of cases with electrocardiographic LVH (16.7%) than the Cornell index (12.8%), in addition to showing a significant correlation with increasing degrees of severity of arterial hypertension.

The QT interval is an indirect indicator of cardiac action potential duration, its prolongation constitutes

an important predictor for malignant ventricular arrhythmias and sudden death in many arrhythmogenic syndromes. However, it has also been altered in other situations such as: advanced age, gender, drugs, body mass index, autonomic changes, diabetes mellitus, smoking, heart failure, myocardial ischemia, arterial hypertension, stroke, impaired renal function, hepatic cirrhosis and electrolyte imbalance[38,39]. De Bruin *et al*[40] conducted a case-control study in 700 patients admitted with different comorbidities, of which 140 suffered a cardiac arrest, and observed that there was a high risk of this fatal event associated with the use of different non-antiarrhythmic drugs that abnormally prolong the cQT interval. Many patients in our series used these drugs.

CONCLUSIONS

The most frequent rhythm disorder was atrial fibrillation. Alterations of ventricular repolarization prevailed over those of depolarization, with no association with sex or skin color. There was a considerable number of cases with left atrial abnormality, left ventricular hypertrophy and long QT.

REFERENCES

1. Castellano JM, Narula J, Castillo J, Fauster V. Promoción de la salud cardiovascular global: estrategias, retos y oportunidades. Rev Esp Cardiol. 2014;67(9):724-30.
2. Keach JW, Bradley SM, Turakhia MT, Maddox TM. Early detection of occult atrial fibrillation and stroke prevention. Heart. 2015;101(14):1097-102.
3. Goldberger AL, Goldberger ZD, Shvilkin A. Goldberger's clinical electrocardiography. A simplified approach. 8th ed. Philadelphia: Elsevier Saunders; 2013.
4. Arunachalam K, Lakshmanam S, Maan A, Kumar N, Dominic P. Impact of drug induced long QT syndrome: A systematic review. J Clin Med Res. 2018;10(5):384-90.
5. Ministerio de Salud Pública. Anuario Estadístico de Salud 2017. La Habana: Dirección Nacional de Registros Médicos y Estadísticas de Salud; 2018.
6. Ministerio de Salud Pública. Anuario Estadístico de Salud 2016. La Habana: Dirección Nacional de Registros Médicos y Estadísticas de Salud; 2017.
7. Singer M, Conde-Martel A, Hemmersbach-Miller M, Ruiz-Hernández JJ, Arencibia Borrego J, Alonso Ortiz B. Mortalidad hospitalaria de pacientes nonagenarios en medicina interna. Rev Clin Esp. 2018;218(2):61-5.
8. Merengoni A, Winblad B, Karp A, Fratiglioni L. Prevalence of chronic diseases and multimorbidity among the elderly population in Sweden. Am J Public Health. 2008;98(7):1198-200.
9. Devkota A, Bakhit A, Dufresne A, Naing OA, Parajuli P, Manhas S. Arrhythmias and electrocardiographic changes in systolic heart failure. N Am J Med Sci. 2016;8(4):171-4.
10. Benjamin EJ, Blaha MJ, Chiuve SE, Cushman M, Das RS, Deo R, *et al*. Heart disease and stroke statistics – 2017 update: A report from the American Heart Association. Circulation. 2017;135(10):e146-e603.
11. Kirchhof P, Benussi S, Kotecha D, Ahlsson A, Atar D, Casadei B, *et al*. 2016 ESC Guidelines for the management of atrial fibrillation developed in collaboration with EACTS. Eur J Cardiothorac Surg. 2016;50(5):e1-e88.
12. Kumar S, Sanders P, Kalman JM. Typical and atypical atrial flutter: mapping and ablation. En: Zipes DP, Jalife J, editors. Cardiac electrophysiology. From cell to bedside. 6ª ed. Philadelphia: Elsevier Saunders; 2014. p. 723-37.
13. Vogler J, Breithardt G, Eckardt L. Bradiarritmias y bloqueos de la conducción. Rev Esp Cardiol. 2012;65(7):656-67.
14. De Ponti R, Marazzato J, Bagliani G, Leonelli FM, Padeletti L. Sick Sinus Syndrome. Card Electrophysiol Clin. 2018;10(2):183-95.
15. Blanck AC, Loh P, Vos MA. Atrioventricular block. En: Zipes DP, Jalife J, editors. Cardiac electrophysiology. From cell to bed side. 6ª ed. Elsevier Saunders; 2014. p. 1043-9.
16. Surawicz B, Childers R, Deal BJ, Gettes LS, Bailey JJ, Gorgels A, *et al*. AHA/ACCF/HRS Recommendations for the standardization and interpretation of the electrocardiogram. Part III: Intraventricular conductions disturbances: a scientific statement from the American Heart Association Electrocardiography and Arrhythmias Committee, Council on Clinical Cardiology; the American College of Cardiology Foundation; and the Heart Rhythm Society. Endorsed by the International Society for Computerized Electrocardiology. J Am Coll Cardiol. 2009;53(11):976-81.
17. Surawicz B, Knilans TK. Chou's electrocardiography in clinical practice. 6ª ed. Philadelphia: El-

sevier Saunders; 2008.
18. Uribe W, Venegas DI, Negrete A, Orjuela A, Álvarez A, Arenas AE, *et al*. Guías colombianas de electrofisiología cardiovascular. Recomendaciones clínicas y niveles de evidencia. Actualización 2011. Rev Colomb Cardiol. 2011;18(Supl. 3):201-95.
19. Wesley K. Huszar Arritmias: Interpretación y tratamiento. 4ª ed. Madrid: Elsevier; 2012.
20. Monin J, Bisconte S, Nicaise A, Hornez AP, Manen O, Perrier E. Prevalence of intraventricular conduction disturbances in a large French population. Ann Noninvasive Electrocardiol. 2016; 21(5):479-85.
21. Kawabata-Yoshihara LA, Benseñor IM, Kawabata VS, Menezes PR, Scazufca M, Lotufo PA. Prevalence of electrocardiographic findings in elderly individuals: the Sao Paulo aging & health study. Arq Bras Cardiol. 2009;93(6):602-7, 651-6.
22. Xiong Y, Wang L, Liu W, Hankey GJ, Xu B, Wang S. The prognostic significance of right bundle branch block: A meta-analysis of prospective cohort studies. Clin Cardiol. 2015;38(10):604-13.
23. O'Neal WT, Qureshi W, Li Y, Soliman EZ. RSR' pattern and the risk of mortality in men and women free of cardiovascular disease. J Electrocardiol. 2015;48(3):430-3.
24. Prineas RJ, Le A, Soliman EZ, Zhang ZM, Howard VJ, Ostchega Y, *et al*. United States national prevalence of electrocardiographic abnormalities in black and white middle-age (45- to 64-Year) and older (≥65 year) adults (from the Reasons for Geographic and Racial Differences in Stroke Study). Am J Cardiol. 2012;109(8):1223-8.
25. Molaschi M, Ponzetto M, Romin R, Berrino E, Fabris F. Changes in the electrocardiogram in the elderly patient. The limits between normality and pathology. Recenti Prog Med. 1995;86(1):32-6.
26. Furberg CD, Manolio TA, Psaty BM, Bild DE, Borhani NO, Newman A, *et al*. Major electrocardiographic abnormalities in persons aged 65 years and older (The Cardiovascular Health Study). Cardiovascular Health Study Collaborative Research Group. Am J Cardiol. 1992;69(16):1329-35.
27. Healy CF, Lloyd-Jones DM. Association of traditional cardiovascular risk factors with development of major and minor electrocardiographic abnormalities: A systematic review. Cardiol Rev. 2016;24(4):163-9.
28. Badheka AO, Rathod A, Marzouka GR, Patel N, Bokhari SS, Moscucci M, *et al*. Isolated nonspecific ST-segment and T wave abnormalities in a cross-sectional United States population and mortality (from NHANES III). Am J Cardiol. 2012; 110(4):521-5.
29. Mirvis DM, Goldberger AL. Electrocardiografía. En: Mann DL, Zipes DP, Libby P, Bonow RO, eds. Braunwald. Tratado de Cardiología. Texto de Medicina Cardiovascular. 10ma Ed. Barcelona: Elsevier; 2015. p. 114-154.
30. Rowell D, Nghiem HS, Jorm C, Jackson TJ. How different are complications that affect the older adult inpatient. Qual Saf Health Care [Internet]. 2010 [citado 10 Ene 2019];19(6):e34. Disponible en: http://dx.doi.org/10.1136/qshc.2009.032235
31. Lehtonen AO, Langén VL, Puukka PJ, Kähönen M, Nieminen MS, Jula AM, *et al*. Incidence rates, correlates, and prognosis of electrocardiographic P-wave abnormalities − a nationwide population-based study. J Electrocardiol. 2017;50(6):925-32.
32. Kilcoyne MM, Davis AL, Ferrer MI. A dynamic electrocardiographic concept useful in the diagnosis of cor pulmonale: Result of a survey of 200 patients with chronic obstructive pulmonary disease. Circulation. 1970;42(5):903-24.
33. Mazzoleni A, Wolff R, Wolff L, Reiner L. Correlation between component cardiac weights and electrocardiographic patterns in 185 cases. Circulation. 1964;30:808-29.
34. Peguero JG, Lo Presti S, Pérez J, Issa O, Brenes JC, Tolentino A. Electrocardiographic criteria for the diagnosis of left ventricular hypertrophy. J Am Coll Cardiol. 2017;69(13):1694-703.
35. Lu N, Zhu JX, Yang PX, Tan XR. Models for improved diagnosis of left ventricular hypertrophy based on conventional electrocardiographic criteria. BMC Cardiovasc Disord [Internet]. 2017 [citado 14 Ene 2019];17:217. Disponible en: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5549337/pdf/12872_2017_Article_637.pdf
36. Su FY, Li YH, Lin YP, Lee CJ, Wang CH, Meng FC, *et al*. A comparison of Cornell and Sokolow-Lyon electrocardiographic criteria for left ventricular hypertrophy in a military male population in Taiwan: the Cardiorespiratory fitness and HospItalization Events in armed Forces study. Cardiovasc Diagn Ther. 2017;7(3):244-51.
37. Mbaye A, Dodo B, Ngaïde AA, Sy NF, Babaka K, Mingou JS, *et al*. Left ventricular hypertrophy in black African subjects with artery hypertension: Results of a cross-sectional survey conducted in semi-rural area in Senegal. Ann Cardiol Angeiol (Paris). 2017;66(4):210-6.
38. Castro-Torres Y, Carmona-Puerta R, Katholi RE. Ventricular repolarization markers for predicting

malignant arrhythmias in clinical practice. World J Clin Cases. 2015;3(8):705-20.

39. Mozos I, Caraba A. Electrocardiographic predictors of cardiovascular mortality. Dis Markers [internet]. 2015 [citado 15 Ene 2019];2015:727401. Disponible en: http://downloads.hindawi.com/journals/dm/2015/727401.pdf
40. De Bruin ML, Langendijk PN, Koopmans RP, Wilde AM, Lufkens HG, Hoes AW. In-hospital cardiac arrest is associated with use of non-anti-arrhythmic QTc-prolonging drugs. Br J Clin Pharmacol. 2007;63(2):216-23.