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Investigation of Heart Rate Variability and Ventricular Repolarization Indexes in Brucella Patients with Palpitations

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Variabilita srdeční frekvence

SOUHRN

Kontext: Celosvětově se vyskytující zoonotická onemocnění jako brucelóza zvyšují mortalitu na onemocnění srdce i výskyt maligních arytmií. Variabilita srdeční frekvence (heart rate variability, HRV) se měří neinvazivně se spolehlivým výsledkem. Nižší hodnoty HRV ukazují na autonomní dysfunkci. K detekci komorových arytmií se používají poměry intervalu Tp-e/QT (QT) a korigovaného QT (QTc).
Cíl: U pacientů s brucelózou jsme zkoumali vztah mezi autonomní dysfunkcí a repolarizací komor (ventricular repolarization, VR). Hodnocení se provádělo neinvazivně měřením parametrů HRV a VR.
Metody: Do studie bylo zařazeno 100 pacientů s brucelózou; jejich průměrný věk byl 39,2 ± 1,1 roku. Kontrolní skupinu srovnatelného věku a poměru obou pohlaví tvořilo 100 zdravých dobrovolníků průměrného věku 44,3 roku. Vypočítávali a zaznamenávali jsme hodnoty Tp-e, QT a QTc i poměr Tp-e/QTc stejně jako hodnoty HRV.
Výsledky: Pacienti s brucelózou měli značně vyšší hodnoty QT_{max}, QTc_{max}, QT_{min} a QTc_{min} než kontroly. Poměry rozptylu hodnot Tp-e, cTp-e, Tp-e/QTc a Tp-e byly statisticky významně vyšší u pacientů s brucelózou než u kontrolních jedinců (80,2 ± 4,4 a 73,8 ± 5,4; $p < 0,001$, resp. 87,5 ± 6,2 a 82,6 ± 7,8; $p = 0,001$, 0,20 ± 0,01 a 0,21 ± 0,01; $p = 0,004$ a 29,4 ± 11,9 a 21,7 ± 10,2). U pacientů s brucelózou byly nalezeny vyšší poměry LF/HF během dne a během noci ($p < 0,001$). Poměry LF/HF během dne a během noci příznivě korelovaly s hodnotami Tpe_cQT (r = 0,700; $p < 0,001$, resp. r = 0,746; $p < 0,001$).
Závěry: Při elektrokardiografickém vyšetření měli pacienti s brucelózou delší intervaly Tp-e a vyšší poměry QT i QTc. U pacientů s brucelózou byly zjištěny jisté známky zvýšené HRV včetně poměru LF/HF. Byla prokázána příznivá korelace hodnot LF/HF a Tp-e/QTc. Brucelóza může působit subklinické postižení srdce a autonomní dysfunkci. Tito pacienti vyžadují důslednější screening komorových arytmií.

Keywords:
Brucellosis
Heart rate variability
High frequency power/low frequency power
Tp-e interval
Tp-e/QT ratio

ABSTRACT

Background: Global zoonotic diseases like brucellosis increase cardiac mortality and malignant arrhythmias. Heart rate variability (HRV) measures heart rate non-invasively and reliably. Lower HRV suggests autonomic dysfunction. The Tp-e/QT interval (QT) and corrected QT (QTc) ratios are used to detect ventricular arrhythmogenesis.
Objective: In brucellosis, we examined the relationship between autonomic dysfunction and ventricular repolarization (VR). This was done noninvasively by assessing HRV and VR parameters.
Methods: One hundred patients with brucellosis had a mean age of 39.2±1.1 years. One hundred healthy volunteers with a mean age of 44.3 years made up the control group, which was age and sex matched. We calculated and recorded Tp-e, QT, QTc, and Tp-e/QTc, as well as HRV values.
Results: Brucellosis patients had considerably greater QT_{max}, QTc_{max}, QT_{min}, and QTc_{min} than controls. Tp-e, cTp-e, Tp-e/QTc, and Tp-e dispersion ratios were significantly greater in brucellosis patients compared to the control group (80.2±4.4 and 73.8±5.4, $p < 0.001$; 87.5±6.2 and 82.6±7.8, $p = 0.001$; 0.20±0.01 and 0.21±0.01, $p = 0.004$; 29.4±11.9 and 21.7±10.2. Patients with brucellosis had greater LF/HF ratios during daylight and overnight ($p < 0.001$). Daytime and nighttime LF/HF ratios were favourably linked with Tpe_cQT (r = 0.700, $p < 0.001$, and r = 0.746, $p < 0.001$, respectively).
Conclusions: On electrocardiography, brucellosis patients had longer Tp-e intervals, QT ratios, and QTc ratios. Brucellosis patients had increased HRV traits, including the LF/HF ratio. LF/HF and Tp-e/QTc correlated favourably. Brucellosis may cause subclinical cardiac engagement and autonomic dysfunction. These patients need more ventricular arrhythmia screening.

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Introduction

Brucellosis, a systemic disease, is recognised as the prevailing zoonotic ailment globally. It can be transmitted to people by various means, including contact with body fluids, urine, or the consumption of raw foetal tissues from infected livestock such as sheep, goats, cattle, and pigs.[1] Zoonotic illnesses have emerged as a significant concern, leading to substantial economic losses and public health challenges in emerging nations, including our own.[2] Cardiac involvement manifests as endocarditis, myocarditis, or pericarditis. The occurrence of isolated cardiac or pericardial involvement is infrequent. Myocardial injury might arise from the organism itself, an excessive production of immunocomplexes, or inflammatory cytokines.[3]

If the myocardium is affected, it could lead to the development of harmful atrial or ventricular arrhythmias (VA) in the heart's conduction system, which could end fatally.[4,5] The presence of pathological alterations in the myocardium of the atria and ventricles in individuals with brucellosis can lead to the development of arrhythmias affecting either the atria or ventricles.[6,7] Consequently, individuals with atrial and VA may have cardiovascular instability due to potential inadequacies in their medical therapy.

The QT interval (QT), corrected QT interval (QTc), QT dispersion (QTd), and transmural dispersion of repolarization (TDR) can be used to assess cardiac repolarization.[8,9] The ECG Tp-to-E interval, which measures the time between the peak and tip of the T wave, is typically used to measure T-wave dispersion.[9] However, several studies have used the Tp-e/QT and Tp-e/QTc ratios as potential electrocardiographic indicators of ventricular arrhythmogenesis.[10]

The measurement of autonomic nervous system (ANS) activity is often conducted using a battery of tests assessing cardiovascular autonomic function. Heart rate variability (HRV) is a readily accessible, non-invasive, and dependable metric that assesses the neural control of heart rate. A potential indicator of autonomic dysfunction may be the presence of reduced HRV. HRV has been proven to be connected with higher cardiovascular disease mortality and morbidity. This association has been widely acknowledged to be particularly linked to a higher incidence of sudden cardiac mortality and arrhythmia.[11]

The objective of this study was to examine the prompt identification of cardiac autonomic dysfunction and the correlation between autonomic dysfunction and the possibility of malignant arrhythmias in individuals diagnosed with brucellosis. In this study, we investigated the potential of HRV and ventricular repolarization (VR) parameters as a noninvasive approach for assessing brucellosis patients.

Methods

Study design

The study was a case control study. This study was performed in compliance with the Declaration of Helsinki.

Study population

This study was conducted with a total population of 100 patients who were diagnosed with brucellosis between January 2019 and January 2020 and met our study criteria. For the control group, 100 gender- and age-matched healthy volunteers were randomly selected. The study protocol was approved by the local ethics committee. An informed written consent form was requested from each patient. Brucellosis was diagnosed with bacterial growth in blood and/or tissue cultures or no growth but a Wright and/or Coombs Wright test titer of 1/160 or higher. Patients with a diagnosis of brucellosis and palpitations in the Infectious Diseases outpatient clinic and ward were consulted in the cardiology clinic.

A comprehensive assessment was conducted in the cardiology outpatient clinic, encompassing physical measurements such as weight, height, body surface area, blood pressure, and peak heart rate. Additionally, electrocardiographic and echocardiographic examinations were

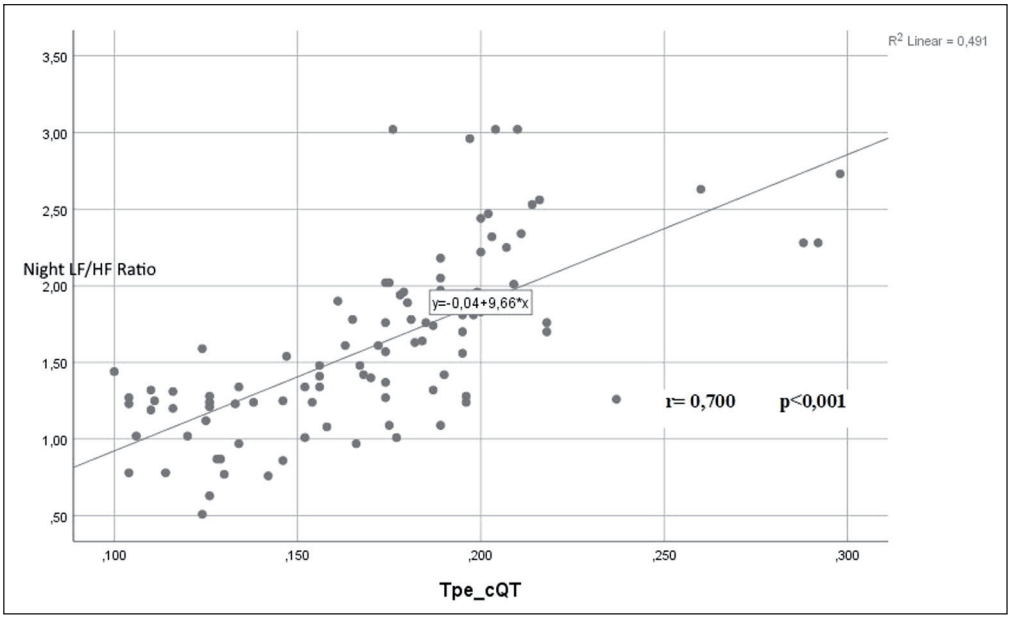

Fig. 1 –The correlation between nighttime LF/HF ratio and Tpe_cQT.

carried out. Standard investigations were prescribed, and a 24-hour Holter monitor was sought for the purpose of monitoring the patient's cardiac rhythm. Exclusions were made for those with diabetes, hypertension, arrhythmia, hyperthyroidism, chronic renal failure, migraine, epilepsy, or any infectious condition other than brucella, as well as those using QT-prolonging drugs or drugs that may impact the autonomic nervous system (**Fig. 1**).

Ambulatory ECG

The acquisition of all full-day Holter recordings was conducted using a two-channel bipolar recorder. All patients exhibited nearly identical daily routine activities. A 24-hour continuous recording of ambulatory ECG was conducted using the DR-512 VX3 ECG recording system (Century series Holter analysis system; Biomedical Systems, Maryland Heights, MO, USA). The electrodes were strategically placed in order to get leads CM2 and CM5. In the context of the given temporal framework, the period from 08:00 to 24:00 was conventionally classified as daytime, while the period from 00:00 to 08:00 was typically classified as nighttime. The analysis of all recordings was conducted by a cardiologist with extensive expertise in the field.

Analysis of HRV

The evaluation of autonomic function in all patients was conducted by analysing the power spectrum analysis of RR interval variability. The ECG data underwent digitization, wherein they were converted into a digital format and afterwards saved on a hard disc. The digitization process involved sampling the signals at a rate of 500 Hz and utilising 12 bits of precision. The concurrent recording of the respiratory signal with the ECG traces was conducted in order to capture any variations in breathing frequency and depth.[12]

Time domain indices

The HRV indices that were assessed include: The standard deviation of the time interval between successive normal QRS complexes, also known as the NN interval, is referred to as SDNN. The SDANN refers to the standard deviation of the mean NN interval derived from five-minute recordings collected across a 24-hour duration. The SDNN index refers to the average value of the standard deviation of the 24-hour NN interval derived from a five-minute recording. rMSSD refers to the calculation of the arithmetic mean of the square root of the difference between consecutive NN intervals. This particular indicator typically signifies vagal modulation. The metrics of rMSSD and PNN50 offer insights into the transient characteristics of HRV and serve as indicators of rapid fluctuations in heart rate. The SDNN, SDANN, and SDNN indices exhibit diurnal interactions, but the impact of heart rate respiration on short-term variations is limited.[13] The variable NN50 represents the count of intervals in which the duration between consecutive NN intervals exceeds 50 milliseconds (ms). pNN50 refers to the proportion of NN50 events in relation to the overall count of NN intervals. The HRV triangle index is a metric derived from the transformation of NN interval data into a geometric shape.

Frequency-domain indices

The utilisation of power spectral density analysis enables the decomposition of the HRV signal into distinct spectrum components and their respective intensities. The spectrum analysis of short-term or long-term 24-hour HRV recordings typically spans a duration of 2 to 5 minutes. This approach involves the segregation of the heart rate data based on its frequency and intensity. Information regarding various changes in heart rate can be acquired by utilising periodic fluctuations of the heart rate at different frequencies.[14]

The power spectral density analysis encompasses the measurement of four frequencies ranging from 0 to 0.5 Hz. The aforementioned components are classified as ultra-low frequency (ULF), very low frequency (VLF), low frequency (LF), and high frequency (HF). The utilisation of LF, HF, and their corresponding ratios (LF/HF) is prevalent within these specific frequency bands. There exists a perspective that posits frequency analysis as the primary determinant of parasympathetic nervous system function. The LF/HF ratio exhibits variability in response to fluctuations in LF and HF; however, the majority of research findings indicate that an elevation in the LF/HF ratio signifies a prevailing influence of sympathetic nervous system activity. The correlation between VLF and ULF components and physiological processes remains uncertain.[14]

Electrocardiographic and echocardiographic assessments

Philips affinity 50 ultrasound imaging equipment with an S4-2 transducer was utilised for echocardiograms. The subject was in the left lateral decubitus for the parasternal long and short axes and apical 4 and 2 space pictures. Left atrial, left ventricular end-systolic, and end-diastolic diameters were determined using two-dimensional imaging. Simpson's method computed ejection %. For PW Doppler apical four-chamber view, the sample volume was at the mitral valve leaflet apex. The maximum early and late diastolic peak transmitral flow velocity (E and A) in cm/s were observed at this site. A/E ratio calculated. E-wave deceleration was ms. Mitral lateral annulus peak early, late, and systolic wave velocities were determined using tissue Doppler in apical four-cavity imaging. The Doppler measured myocardial isovolumetric relaxation time (IVRT), contraction time, and ejection time in ms. E/Em was computed.

Tokyo, Japan's Nihon Kohden ECG recorder has 50 mm/s paper speed and 10 mm/mV voltage sensitivity. Two blinded cardiologists measured the maximum and minimum QT and Tp-e intervals. We used callipers to measure QT and Tp to reduce mistakes. Patients with U-waves on their ECGs were excluded. The time from QRS complex onset to the T wave end was used to measure the QT interval. For heart rate fluctuations, Bazett's formula was used to alter the QT interval: $QTc = QT\sqrt{}$ (R-R interval). QTmax and QTmin were the longest and smallest observed periods of QT waves in any lead, respectively. The difference between the longest and shortest QTc intervals was used to calculate the adjusted QTd. Tp-Te is the time between the T-wave peak and termination. Precordial leads were measured at TP-e. Recorded values were used to calculate Tp-e/QT and QTc ratios.

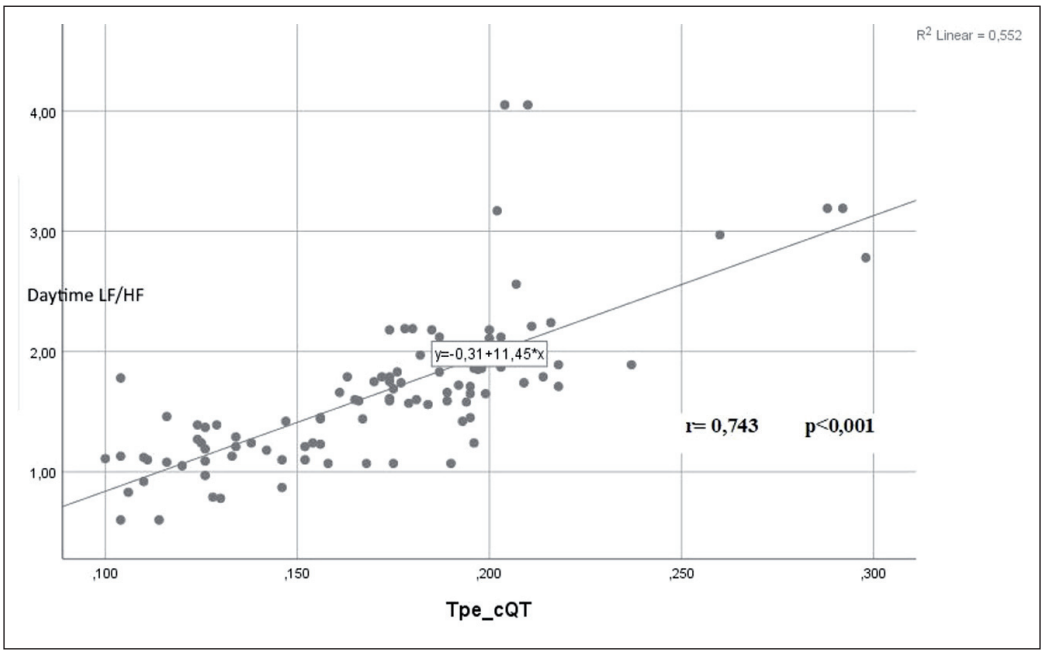

Fig. 2 – The correlation between daytime LF/HF ratio and Tpe_cQT.

Statistical analysis

The statistical analysis was done using SPSS 21 for Windows, created in Chicago, IL, USA. Our study examined statistical analyses with 95% confidence. Categorical variables were analyzed using the Chi-square test and continuous variables with and without normal distribution were analyzed using the Student's T and Mann-Whitney tests, respectively. Correlations between Tpe_cQT, daytime, and nighttime LF/HF ratios were assessed with Pearson's and Spearman's correlation coefficients. The significance level adopted in the statistical analysis was 5%.

Results

The study included 100 brucellosis patients and 100 healthy controls. The proportion of male individuals in the brucellosis patient group was found to be 56%, whereas in the control group, this proportion was seen to be 46%. Upon demographic evaluation of the groups, it was seen that the data exhibited similarity in all aspects except for age. The control group had a statistically significant greater mean age compared to the mild brucellosis group. The biochemical and hemogram parameters exhibited similarities between the groups. Compared to other groups, the control group had a statistically significant increase in systolic blood pressure (SBP). There was no discernible distinction seen among the groups with regards to echocardiographic characteristics, as indicated in **Table 1**.

The groups' electrocardiographic parameters are in **Table 2**. The brucellosis group had significantly higher QT_{max}, QTc_{max}, QT_{min}, and QTc_{min} than the control group. Brucellosis patients had significantly higher Tp-e, cTp-e, Tp-e/QTc, and Tp-e dispersion ratios compared to the control group (80.2±4.4 and 73.8±5.4, p <0.001; 87.5±6.2 and 82.6±7.8, p = 0.001; 0.20±0.01 and 0.21±0.01, p = 0.004; 29.4±11.9, and 21.7±10.2, p< 0.001, as shown in **Table 2**). QTd was not significantly different across groups (p> 0.05). The kappa score's interobserver reliability was 86% with a 95% CI, indicating high agreement.

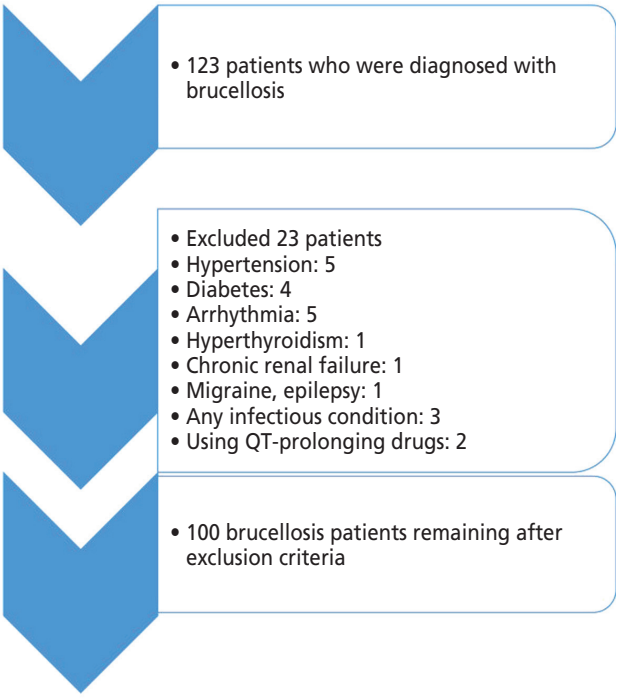

Fig. 3 – Central illustration: investigation of heart rate variability and ventricular repolarization indexes in brucella patients with palpitations.

Intergroup HRV temporal values were not significantly different (p >0.05). **Table 3** shows that the LF/HF ratios in the brucellosis group were considerably higher during both daylight and evening (p <0.001). Both daytime and nighttime LF/HF ratios were positively correlated with Tpe_cQT (r = 0,700, p <0.001 and r = 0.746, p <0.001, respectively), as shown in **Figures 2 and 3**.

Table 1 – Baseline clinical and laboratory characteristics of the study population

	Brucellosis (n = 100)	Control (n = 100)	*p*-value
Age, years	39.2±1.1	44.3±1.0	**0.025**
Gender, male, n (%)	56 (56)	46 (46)	0.064
BMI (kg/m^2)	26.3±3.6	27.6±5.1	0.156
SDB (mmHg)	113.9±8.7	119.3±13.8	**0.020**
DBP (mmHg)	71.6±7.8	73.0±9.4	0.402
HR (beats/min)	73.9± 1.0	72.5±1.0	0.465
Glucose (mg/dL)	99.5±11.7	105.1±29.4	0.102
BUN (mg/dL)	12.2±2.8	13.4±3.0	0.633
Creatine (mg/dL)	0.83±0.13	0.83±0.15	0.859
T. arm (mg/dl)	192.7±34.0	191.5±34.7	0.240
TG (mg/dl)	143.0±11.5	160.0±10.8	0.855
HDL (mg/dl)	49.5±10.4	47.1±10.7	0.254
LDL (mg/dl)	112.7±31.9	110.8±30.4	0.761
BKS (10^3 × µL)	7.0±1.5	6.8±2.1	0.486
Hemoglobin (g/dL)	14.6±1.6	14.2±1.6	0.254
Platelets (× 103/µL)	266.5±40.7	254.4±55.8	0.219
CRP (mg/L)	6.2±1.6	4.2±1.2	0.365
Sedimentation (mm/h)	13.3±6.5	12.8±8.9	0.756
Echocardiography (2D)			
LVEF (%)	61.2±2.9	62.0±2.7	0.140
SVEDC (mm)	46.5±2.8	46.6±3.4	0.875
SVESC (mm)	27.5±2.3	27.7±2.7	0.671
IVS (mm)	1.1±0.2	1.1±0.4	0.936
PDC (mm)	0.8±0.1	0.8±0.2	0.837
HAIR (mm)	3.4±0.2	3.4±0.3	0.932
PABP (mmHg)	24.9±2.3	24.6±2.9	0.232
E/A	1.2±0.2	1.1±0.1	0.104
DZ	193.5±32.9	202.1±22.4	0.132
IVRT	72.6±11.3	75.1±11.3	0.260
IVCT	51.1±11.2	49.8±11.8	0.845
ET	286.8±33.6	281.8±35.0	0.463
E/Em	5.8±1.1	6.0±1.0	0.324

BMI – body mass index; BUN – blood urea nitrogen; CRP – C-reactive protein; DBP – diastolic blood pressure; DZ – deseleration time; ET – ejection time; HDL – high density lipoprotein; IVCT – interventricular contraction time; IVRT – interventricular relaxation time; HR – heart rate; LAD – left atrial diameter; LDL – low density lipoprotein; LVEDC – left ventricular end diastolic diameter; LVEF – left ventricular ejection fraction; LVESC – left ventricular end systolic diameter; PAD – posterior wall; PAP – pulmonary artery pressure; SBP – systolic blood pressure; T. arm – total cholesterol; TG – triglycerides; WBC – white blood cell count.

Discussion

This study is the inaugural investigation into the correlation between HRV and VR parameters among individuals diagnosed with brucellosis. The findings of our study indicate that individuals diagnosed with brucellosis exhibited a significantly elevated LF/HF ratio in comparison to the control group. Furthermore, our research showed that the Tp-e, cTp-e, Tp-e/QTc, and Tp-e dispersion ratios were higher in people who had been diagnosed with brucellosis compared to healthy people. Nevertheless, a statistically significant positive connection was seen between the LF/HF ratios and Tp-e/QTc.

Cardiac manifestations in cases of Brucella infection might exhibit a diverse range of clinical presentations, encompassing endocarditis, myocarditis, or pericarditis. However, the most prevalent and significant consequence among these is endocarditis.[3] The precise understanding of the relationship between Brucella infection and its impact on morbidity and mortality in the cardiovascular sys-

Table 2 – Electrocardiographic parameters of the study group

	Brucellosis (n = 100)	Control (n = 100)	*p*-value
QT_{min} (ms)	365.2±19,8	348.7±20.8	**0.001**
cQT_{min} (ms)	399.5±20.0	385.5±21.4	**0.006**
QT_{max} (ms)	390.3±18.7	373.6±25.5	**0.001**
cQT_{max} (ms)	427.6±20.6	412.3±26.5	**0.007**
Tp-e (ms)	80.2±4.4	73.8±5.4	**<0.001**
cTp-e (ms)	87.5±6.2	82.6±7.8	**0.001**
QTd (ms)	25.1±10.6	23.1±11.7	0.707
Tp-e dispersion	29.4±11.9	21.7±10.2	**<0.001**
Tp-e/cQT	0.20±0.01	0.21±0.01	**0.004**

cTp-e – corrected transmural dispersion of repolarization; QTc_{min} – corrected QT minimum; QTcd – corrected QT dispersion; QTd – QT dispersion; QT_{max} – corrected QT_{max}; QT_{min} – QT minimum; Tp-e – transmural dispersion; Tp-e/QT – transmural dispersion of repolarization; Tp-e/QTc – transmural dispersion of repolarization/corrected QT.

Table 3 – Heart rate variability of the study group

Daytime HRV time analysis	Brucellosis (n = 100)	Control (n = 100)	*p*-value
SDNN	119.1±34.2	123.9±33.2	0.552
SDANN	96.6±35.2	103.0±27.2	0.342
PNN50	9.9±7.7	10.9±9.8	0.568
rMSSD	52.3±62.5	62.7±86.1	0.490
Daytime HRV frequency analysis			
Total power (ms^2)	9475.6±6144.1	11684.3±7472.3	0.110
ULF power (ms^2)	4705.8±3174.2	5765.5±3487.7	0.115
VLF power (ms^2)	2504.5±1753.3	3015.9±1928.6	0.169
LF power (ms^2)	1741.8±1239.4	1522.2±867.2	0.307
HF power (ms^2)	871.9±697.3	840.6±523.7	0.800
LF NUs	54.6±12.2	55.4±12.9	0.756
HF NUs	41.3±9.3	39.4±12.3	0.385
LF/HF ratio	1.9±0.6	1.4±0.4	**<0.001**
Night HRV time analysis			
SDNN	107.5±39.2	117.4±34.2	0.200
SDANN	74.6±42.0	86.9±41.2	0.142
PNN50	17.6±15.6	20.3±17.4	0.418
rMSSD	52.0±24.0	54.1±29.6	0.691
Night HRV frequency analysis			
Total power (ms^2)	8898.5±5619.5	10279.2±6691.3	0.267
ULF power (ms^2)	2295.2±2096.6	3370.9±2053.7	0.368
VLF power (ms^2)	2970.8±2373.2	3715.9±3020.7	0.173
LF power (ms^2)	1727.8±1506.0	1674.6±1469.4	0.858
HF power (ms^2)	1227.9±1197.3	1275.2±1356.3	0.854
LF NUs	86.0±17.1	55.5±11.5	0.215
HF NUs	45.4±13.1	43.6±11.0	0.452
LF/HF ratio	1.8±0.5	1.3±0.4	**<0.001**

HF – high frequency; LF – low frequency; NUs – normalized units; ULF – ultra low frequency; VLF – very low frequency.

tem remains incomplete. Hence, there is a requirement for novel approaches to evaluate the risk and identify early signs of cardiovascular system involvement.

Multiple processes have an impact on the heart tissue when inflammation occurs. The initiation of apoptosis in cardiomyocytes is triggered by the activation of caspase-3, while autonomic dysfunction in the heart is a result of apoptosis in the autonomic centres involving both neuronal and glial cells.[4,5] Moreover, the infiltration of immunocytes, particularly macrophages and neutrophils, as a consequence of inflammation leads to subendocardial haemorrhage and interstitial fibrosis.[15]

In addition to inducing inflammation, this physiological response also gives rise to disruptions in the heart's conduction system. Numerous studies have demonstrated a heightened susceptibility to arrhythmias as a result. Cardiac myocyte damage may manifest in infectious situations and can impact the cardiac conduction system even in the absence of myocardial injury. This is mostly attributed to the release of pro-inflammatory mediators, which have the potential to induce the onset of atrial and VA, ultimately culminating in fatality.[16]

QTd is a metric used to assess the variability in VR.[17,18] It is widely recognised that the presence of extended QTd is closely linked to the occurrence of severe VA and sudden cardiac death. The association between prolonged QTd and life-threatening arrhythmias has been documented in various clinical scenarios, including inflammation, administration of certain antiarrhythmic medications, postoperative cases of tetralogy of Fallot, hypertrophic cardiomyopathy, myocardial infarction, valvular disease, and drug toxicity.[19] In contrast to the aforementioned information, our study did not find any statistically significant disparity between those diagnosed with brucellosis and those who were deemed healthy.

Some people think that the new Tp-e parameter in electrocardiography (ECG) could show how the VR spreads across the myocardium. It has also been seen that having a high Tp-e interval and Tp-e/QT ratio is connected to having malignant VA.[20] In their research, Ozdemir et al. found that patients with sepsis had significantly higher amounts of QTc, Tp-e, Tp-e/QT, and Tp-e/QTc ratios than the control group. The authors proposed that the measurement of Tp-e and Tp-e/QT could serve as useful indicators for predicting mortality in individuals diagnosed with sepsis.[20] The current study looked at how cQTmin, cQTmax, Tp-e, and Tp-e/QTc ratios were higher in people who had been diagnosed with brucellosis compared to a healthy control group.

The findings of our study indicate a potential correlation between brucella infection and myocardial inflammation, which in turn may impact the functionality of the cardiac communication system. It is hypothesised that there is a positive correlation between elevated Tp-e, Tp-e/QTc, and Tp-e dispersion ratios in individuals diagnosed with brucellosis, leading to an augmentation of VR heterogeneity and the subsequent occurrence of VA. This association may contribute to a better understanding of the underlying pathophysiological mechanisms responsible for arrhythmia development in this patient population. Furthermore, the study group did not see any significant changes in QTd values during the therapy period. Further investigation is warranted to ascertain whether the observed phenomenon is temporary or persistent, even in the light of the administered medication.

Previous studies have proposed that Tp-e dispersion, Tp-e/QT ratio, and Tp-e/QTc are more effective indicators of VR compared to QT parameters.[21] In the present investigation, it was shown that the QTd exhibited an increment; however, this observed increment did not attain statistical significance among those diagnosed with brucellosis. This phenomenon could potentially be attributed to the limited sample size of patients or the observation that QTd exhibits a delayed deterioration compared to other parameters associated with VR.

Bruchellosis causes HRV variability, sympathetic overactivity, or decreased vagal activity. Myocarditis, fibrillary stress, and fibrosis might disrupt cellular electrical flow and create aberrant impulses that can trigger reentry mechanisms and malignant arrhythmias in brucellosis.[22] Reduced parasympathetic tone, sympathetic overrelease, and baroreceptor dysfunction diminish HRV.[23] Elderly hypertensives with autonomic nervous system dysfunction have decreased parasympathetic tone and increased sympathetic activity.[24] Standardised LF spectral component power indicates sympathetic modulation in healthy adults. LF/HF shows the heart's sympathovagal balance.[12] We believe this is the first HRV investigation in VR-positive brucellosis patients. More randomised controlled trials are needed to resolve this issue.

Limitations

This study has limitations. Cross-sectional design limited ventricular arrhythmia follow-up, our study's principal weakness. Long-term Holter recording could aid in ventricular arrhythmia detection in these patients. The tiny sample size and single-centre design were significant drawbacks. More participants in long-term, multicenter trials may help us understand our findings.

Conclusion

This study demonstrated that brucellosis had greater cardiac involvement than previously considered, perhaps subclinical. The ECG can quickly measure Tp-e dispersion, Tp-e/QT ratio, and Tp-e/QTc to forecast atrial and VA in these patients. These ECG anomalies in brucellosis patients need further prospective studies to establish their long-term prognosis and the prevalence of arrhythmias in recovered individuals. Additionally, HRV measurements in brucellosis patients could be part of a thorough cardiovascular regulation assessment. This study shows that brucellosis patients should see at least one cardiologist for clinical or subclinical cardiac involvement.

Conflict of interest
No potential conflict of interest relevant to this article was reported.

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Ethical statement

In this study, artificial intelligence (AI)-supported ChatGPT technology was employed. Additionally, the authors claim that the work is devoid of plagiarism, including text and images created by AI.

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