DAFTAR PUSTAKA

Adeoye, M.A., Ogah, O.S., Ovbiagele, B., Akinyemi, R., Shidali, V., Agyekum, F., Aje, A., Adebayo, O., Akinyemi, J.O., Kolo, P. and Appiah, L.T., 2017. Prevalence and Prognostic features of Electrocardiographic Abnormalities in Acute Stroke among Africans: Findings from SIREN. *Global heart*, *12*(2), p.99.

American Heart Association, 2010. Heart Disease and Stroke Statistics_2010 Update: A Report From the American Heart Association. Available from: http://circ.ahajournals.org/cgi/content/full/121/7/e46. [Accessed 28 december 2019]

Arifianto, S.A., Moechammad, S. & Onny, S., 2014. Klasifikasi Stroke Berdasarkan Kelainan Patologos dengan Learning Vector Quantization. Jurnal EECCIS. 8(2):117-22

Battaglini, D., Robba, C., Lopes da Silva, A., dos Santos Samary, C., Leme Silva, P., Dal Pizzol, F., Pelosi, P. and Rocco, P.R.M., 2020. Brain–heart interaction after acute ischemic stroke. *Critical Care*, *24*, pp.1-12.

Bo Norrving. 2014. Stroke and Cerebrovascular Disease. 1st Edition. United States: Oxford University Press. pp.9-18, 35-50, 124-139, 236-242.

Braga, G.P., Gonçalves, R.S., Minicucci, M.F., Bazan, R. and Zornoff, L.A., 2020. Strain pattern and T-wave alterations are predictors of mortality and poor neurologic outcome following stroke. *Clinical Cardiology*.

Carr, J. H., Shepherd, R. B., Nordholm, L., & Lynne, D. (1985). Investigation of a new motor assessment scale for stroke patients. *Physical therapy*, *65*(2), 175-180.

Carvalho-Pinto, B.P. and Faria, C.D., 2016. Health, function and disability in stroke patients in the community. *Brazilian journal of physical therapy*, (AHEAD), pp.0-0.

Centre for Disease Control and Prevention. 2017. Strokes Facts. National Center for Chronic Disease Prevention. accesed 28 december 2019. Diunduh dari: < https://www.cdc.gov/stroke/facts.htm >

Chen, Z., Venkat, P., Seyfried, D., Chopp, M., Yan, T. and Chen, J., 2017. Brain–heart interaction: cardiac complications after stroke. *Circulation research*, *121*(4), pp.451-468.

Dharma, S. Cara Mudah Membaca EKG. Jakarta:EGC. 2017

DiPiro J.T., Wells B.G., Schwinghammer T.L. and DiPiro C. V., 2015, Pharmacotherapy Handbook, Ninth Edit., McGraw-Hill Education Companies, Inggris.

Jiang, B., Han, X., Wang, L. and Dong, Q., 2015. Prognosis of early-stage continuous electrocardiogram abnormalities on patients with acute ischemic stroke. *Journal of Stroke and Cerebrovascular Diseases*, *24*(8), pp.1761-1767.

Junaidi, Iskandar., 2011. Stroke Waspadai Ancamannya. Yogyakarta : ANDI.

Kabo, P. Bagaimana Menggunakan Obat-Obat Kardiovaskular Secara Rasional. Jakarta: Balai Penerbit FKUI. 2011.

Katherine Salter Phd. 2016. Post Stroke Depression and Mood Disorders. Heart&Stroke Foundation canadian Partnership for Stoke Recovery. accesed 24 March 2020 Diunduh dari:

http://www.ebrsr.com/sites/default/files/Chapter%2018_Supplementary%20Tables.pdf

Krause T, Werner K, Fiebach JB, Villringer K, Nolte CH. Stroke in right dorsal anterior insular cortex is related to myocardial injury. Ann Neurol. 2017;81(4):502–11.

Kumar, S. ed., 2004. *Muscle strength*. CRC Press.

Mardjono, M. Mekanisme Gangguan Vaskuler Susunan Saraf Dalam Neurologi Klinis Dasar. Dian Rakyat. 2006. Hal: 270-93

Mirjana Vidovic. 2011. Incidence and Types of Speech Disorder in Stroke Patients. Acta Clin Croat. Vol.50. No.4. pp.491-494.

Nijland, R., van Wegen, E., Harmeling-van der Wel, B. and Kwakkel, G., 2010. Presence of Finger Extension and Shoulder Abduction Within 72 Hours After Stroke Predicts Functional Recovery. *Stroke*, 41(4), pp.745-750.

Nouira S, Boukef R, Bouida W, et al. Accuracy of two scores in the diagnosis of stroke subtype in a multicenter cohort study. Annals of Emergency Medicine. 2009;53(3):373-378.

Perdossi. (2011). Guideline Stroke. Jakarta: Perdossi.

Primara, A. B. & Amalia, L., 2015. Stroke pada Usia Muda. Cermin Dunia Kedokteran, 42(10), pp. 736-737.

Purushothaman, S., Salmani, D., Prarthana, K. G., Bandelkar, S. M. G., & Varghese, S. (2014). Study of ECG changes and its relation to mortality in cases of cerebrovascular accidents. *Journal of natural science, biology, and medicine*, *5*(2), 434.

Raj.N.Kalaria. 2016.Stroke Injury, Cognitive Impairment and vascular Dementia. Thesis. University of Ibadan, Nigeria.

RISKESDAS. (2013). Laporan Hasil Riset Kesehatan Dasar (riskesdas) 2013. Jakarta.

Sacco, R.L., et al., 2013. An Updated Definition of Stroke for the 21st Century. American Heart Association Expert Consensus Document. Stroke 44:2064- 2089. Available from: http://stroke.ahajournals.org/content/44/7/2064.

Sage, Michael, et al. "Validity of rating of perceived exertion ranges in individuals in the subacute stage of stroke recovery." *Topics in stroke rehabilitation* 20.6 (2013): 519-527

Sajjan M. Learn ECG In A Day A Systematic Approach. New Delhi: Jaypee. 2013.

Smith,G. 2014. Acute Stroke-Diagnosis and Management. Scotish Universities Medical Journal. Vol.3. No.1. pp.18-27.

Togha, M., Sharifpour, A., Ashraf, H., Moghadam, M. and Sahraian, M.A., 2013. Electrocardiographic abnormalities in acute cerebrovascular events in patients with/without cardiovascular disease. *Annals of Indian Academy of Neurology*, *16*(1), p.66.

Thibaut A, Chatelle C, Ziegler E, et al. Spasticity after stroke: physiology, assessment and treatment. Brain Injury : [BI]. 2013;27(10):1093-1105.

Virani, S., Alonso, A., Benjamin, E., Bittencourt, M., Callaway, C., Carson, A., Chamberlain, A., Chang, A., Cheng, S., Delling, F., Djousse, L., Elkind, M., Ferguson, J., Fornage, M., Khan, S., Kissela, B., Knutson, K., Kwan, T., Lackland, D., Lewis, T., Lichtman, J., Longenecker, C., Loop, M., Lutsey, P., Martin, S., Matsushita, K., Moran, A., Mussolino, M., Perak, A., Rosamond, W., Roth, G., Sampson, U., Satou, G., Schroeder, E., Shah, S., Shay, C., Spartano, N., Stokes, A., Tirschwell, D., VanWagner, L. and Tsao, C., 2020. Heart Disease and Stroke Statistics—2020 Update: A Report From the American Heart Association. *Circulation*, 141(9).

Wassay M., Khatri I.A., Kaul S. (2014). Stroke in South Asian Countries. Neurology, 10, 135-138.

World Health Organization. Global status report on noncommunicable disease 2014: p. 79-90. [online] 2014. [accessed 22 december 2019]; available from: http://www.who.int/nmh/publications/ncd-status-report-2014/en/

World Health Organization. (2016). Stroke Cerbrovascular Accidents. http://www.who.int/topics/cerebrovascular_accident/en/, diakses tanggal 3 Januari 2020.

Lampiran 1. Jurnal

Prognosis of Early-Stage Continuous Electrocardiogram Abnormalities on Patients with Acute Ischemic Stroke

Beisi Jiang, MS, Xiang Han, MD, Liang Wang, MD, and Qiang Dong, MD

Background: To explore the effects of onset time of electrocardiogram (ECG) abnormalities at an early stage of acute ischemic stroke on patient prognosis. Cardiac dysfunction after stroke is a challenge for clinicians. This is a retrospective study of patients in the neurology departments of 23 hospitals in Shanghai and Wuhan, China. *Methods:* The medical records of 351 patients were compared. Chi-square, Kruskal–Wallis, Mann–Whitney *U* tests, and stratification compared subgroups. Logistic regressions analyzed factors associated with modified Rankin Scale (mRS) score. *Results:* ECG abnormalities occurred in 70.1% of patients at an early stage (most were within 48 hours of disease onset) at least once, whereas 45.9% of the patients had ECG abnormalities within 48 hours of onset and at 7 days after onset. The incidence of poor prognosis (mRS >1) was significantly higher in the patients with ECG abnormalities for both time points than that in those with normal ECGs (56.3% versus 32%, odds ratio = 2.166). Most patients demonstrated 1 to 2 ECG abnormalities, and very few patients had 3 or more. Increasing number of ECG abnormalities was mirrored by poorer prognosis. ECG abnormalities occurred within 48 hours and at the seventh day after onset of acute ischemic stroke; the abnormalities that appeared within 48 hours and were still found on the seventh day after onset of the disease were independent predictors of poor patient prognosis. *Conclusions:* The incidence of abnormal ECGs was high in the patients with acute ischemic stroke, and the abnormal ECGs could appear at any stage of the disease. **Key Words:** Acute ischemic stroke—continuous electrocardiogram abnormalities—prognosis—ECG—modified Rankin Scale (mRS).

Introduction

Around 19% of patients with acute ischemic stroke have a major adverse cardiac event and 4% die.[1] This may involve disinhibition of the central nervous system,[2] stress,[3] or activation of the renin–angiotensin–aldosterone system.[4]

From the Department of Neurology, Huashan Hospital, State Key Laboratory of Medical Neurobiology, Fudan University, Shanghai, China.

Received February 9, 2015; revision received March 24, 2015; accepted March 30, 2015.

The authors declare that they did not receive any grant support.

The authors declare that they have no conflict of interest.

Address correspondence to Qiang Dong, MD, Department of Neurology, Huashan Hospital, State Key Laboratory of Medical Neurobiology, Fudan University, Shanghai 200040, China. E-mail: sibei728@163.com.

1052-3057/$ - see front matter

http://dx.doi.org/10.1016/j.jstrokecerebrovasdis.2015.03.043

Acute stage ischemic stroke signs are generally unstable, but 12-lead electrocardiogram (ECG) has been accepted as an effective evaluation method.[5] Acute stage ischemic stroke ECG descriptions have not been updated since 2008.[6] Most studies focus on ECG abnormality presentation,[3,7-10] and mortality,[11,12] not overall prognosis.[13] We explored the incidence and presentation of ECG abnormalities in Chinese acute ischemic stroke patients, and investigated early-stage changes and their effects on prognosis.

Materials and Methods

Patients

The medical records of 351 patients were selected from the neurology departments of 13 hospitals in Shanghai and 10 hospitals in Wuhan between April 2007 and September 2008. The study was approved by the ethical

Received: 27 November 2019 | Revised: 11 February 2020 | Accepted: 14 February 2020
DOI: 10.1002/clc.23348

CLINICAL INVESTIGATIONS

CLINICAL CARDIOLOGY WILEY

Strain pattern and T-wave alterations are predictors of mortality and poor neurologic outcome following stroke

Gabriel P. Braga[1] | Renato S. Gonçalves[2] | Marcos F. Minicucci[2] | Rodrigo Bazan[1] | Leonardo A. M. Zornoff[2]

[1]Botucatu Medical School, Neurology Department, São Paulo State University (Unesp), Botucatu, Brazil

[2]Botucatu Medical School, Internal Medicine Department, São Paulo State University (Unesp), Botucatu, Brazil

Correspondence
Leonardo A. M. Zornoff, Internal Medicine Department, Botucatu Medical School, São Paulo State University (Unesp), Botucatu CEP: 18618-970, Brazil.
Email: lzornoff@fmb.unesp.br

Abstract

Background: Stroke is associated with electrocardiogram (ECG) abnormalities. However, the role of strain pattern as predictor of poor neurologic outcome and mortality after stroke has not yet been demonstrated.

Hypothesis: ECG abnormalities, with a particular focus on ST-segment changes, are predictors of mortality and neurologic disability 90 days after stroke.

Methods: Patients with up to 24 hours of stroke were prospectively recruited. An ECG was taken at the time of admission. The patients' clinical evolution was evaluated during hospitalization and after discharge by means of a prescheduled return in 90 days. The degree of disability was measured by the modified Rankin scale (mRs). In relation to the mRs, patients were divided into those with scores from 0 to 2 and those with scores equal to or greater than 3 at the end of the observation period.

Results: Of the 112 patients studied, 29 (25.8%) died during the study period. Patients who died presented higher National Institute of Health Stroke Scale and mRs scores on admission, elevated biomarkers of myocardial necrosis, and abnormalities on the ECG. The prevalence of ECG abnormalities was 63%. A logistic regression model showed that strain pattern and T-wave alterations were predictors of mortality (odds ratio [OR]: 12.970, 95% confidence interval [CI]: 1.519-110.723, $P = .019$; OR: 3.873, 95% CI: 1.135-13.215, $P = .031$, respectively) and mRs at 90 days (OR: 12.557, 95% CI: 1.671-94.374, $P = .014$; OR: 15.970, 95% CI: 3.671-69.479, $P < .001$, respectively) after stroke, adjusted by sex, age, stroke subtype, entrance NIH, previous mRs score, and stroke thrombolysis.

Conclusion: Strain pattern and T-wave alterations were predictors of mortality and poor neurologic outcome 90 days after stroke.

KEYWORDS
electrocardiogram, mortality, neurologic disability, outcomes, prediction, stroke

Published online: 25.09.2019

Original Article

The QT dispersion and QTc dispersion in patients presenting with acute neurological events and its impact on early prognosis

Kailash Kumar Rahar, Hans Raj Pahadiya, Kishan Gopal Barupal, C. P. Mathur, Manoj Lakhotia

Department of Medicine, Dr. S.N. Medical College, Jodhpur, Rajasthan, India

ABSTRACT

Aims: To find out and investigate whether the QT dispersion and QTc dispersion is related to type and prognosis of the acute stroke in patients presenting within 24 h of the onset of stroke. **Settings and Design:** This was a observational study conducted at Mahatma Gandhi Hospital, Dr. SN. Medical College, Jodhpur, during January 2014 to January 2015. **Subjects and Methods:** The patients presented within 24 h of onset of acute stroke (hemorrhagic, infarction, or transient ischemic event) were included in the study. The stroke was confirmed by computed tomography scan and magnetic resonance imaging. Patients with (i) altered sensorium because of metabolic, infective, seizures, trauma, or tumor; (ii) prior history of cardiovascular disease, electrocardiographic abnormalities' because of dyselectrolytemia; and (iii) and patients who were on drugs (antiarrhythmic drugs, antipsychotic drugs, erythromycin, theophylline, etc.,) which known to cause electrocardiogram changes, were excluded from the study. National Institute of Health Stroke Score (NIHSS) was calculated at the time of admission and Modified Rankin Scale (MRS) at the time of discharge. Fifty age- and sex-matched healthy controls included. **Statistical Analysis Used:** Student's *t*-test, ANOVA, and area under curve for sensitivity and specificity for the test. **Results:** We included 52 patients (male/female: 27/25) and 50 controls (26/24). The mean age of patients was 63.17 ± 08.90 years. Of total patients, infarct was found in 32 (61.53%), hemorrhage in 18 (34.61%), transient ischemic attack (TIA) in 1 (1.9%), and subarachnoid hemorrhage in 1 (1.9%) patient. The QT dispersion and QTc dispersion were significantly higher in cases as compare to controls. (87.30 ± 24.42 vs. 49.60 ± 08.79 ms; $P < 0.001$) and (97.53 ± 27.36 vs. 56.28 ± 09.86 ms; $P < 0.001$). Among various types of stroke, the mean QT dispersion and QTc dispersion were maximum and significantly higher in hemorrhagic stroke as compared to infarct and TIA ($P < 0.001$). The mean QT dispersion and QTc dispersion was found significantly high in nonsurvivors ($n = 16$) as compared to survivors group ($n = 36$) ($P < 0.05$). The mean QT dispersion was directly correlated with the NIHSS and functional outcome score MRS. Patients with greater QT and QTc dispersion having high NIHSS had poor prognosis. **Conclusion:** We concluded that patients presenting with acute neurological events having increased QT dispersion and QTc dispersion is related to high mortality and poor functional outcomes on hospital discharge and if the values of dispersion score are very high we can predict for hemorrhagic stroke.

Key words: Acute stroke, hemorrhage, infarct, prognosis, QT dispersion

Introduction

Stroke is the second most common cause of death in the world, after Coronary Artery Disease-related deaths.[1] It is also a very important single cause responsible for morbidity of disease. The central nervous system (CNS) has an important role in regulation of cardiac activity and vasomotor tones.[2-4] The lesions of the CNS frequently lead to disturbance of cardiovascular system (CVS) and other autonomic functions.[5] The manifestations of such type of autonomic dysregulation are loss of heart rate variability and various electrocardiogram

Address for correspondence:
Dr. Hans Raj Pahadiya,
Department of Medicine, Dr. S.N. Medical College,
Mahatma Gandhi Hospital, Jodhpur, Rajasthan, India.
E-mail: drhans05sms@gmail.com

Access this article online	
Quick Response Code:	Website: www.ruralneuropractice.com
	DOI: 10.4103/0976-3147.172173

How to cite this article: Rahar KK, Pahadiya HR, Barupal KG, Mathur CP, Lakhotia M. The QT dispersion and QTc dispersion in patients presenting with acute neurological events and its impact on early prognosis. J Neurosci Rural Pract 2016;7:61-6.

ARTICLE IN PRESS

Prolonged Corrected QT Interval as a Predictor of Clinical Outcome in Acute Ischemic Stroke

Milan Hromádka, MD, PhD,* Jitka Seidlerová, MD, PhD,†‡
Vladimír Rohan, MD, PhD,§ Jan Baxa, MD, PhD,‖ Jakub Šedivý, MD,*
Daniel Rajdl, MD,¶ Ivan Ulč, MD,* Petr Ševčík, MD, PhD,§ Jiří Polívka, MD, PhD,§
and Richard Rokyta, MD, PhD, Prof*

Background: This study aimed to investigate changes of corrected QT (QTc) interval during acute ischemic stroke and its correlation with high-sensitivity troponin I (hsTnI), brain natriuretic peptide (BNP), neurological outcome, and 1-year mortality. *Methods:* We registered electrocardiogram in 69 patients immediately after admission to the intensive care unit and then after 24 and 48 hours. Computed tomography was performed on admission to determine brain infarct size and localization. Neurological outcome was assessed by modified Rankin scale (mRS) at discharge. *Results:* Forty-five (65.2%) patients had prolonged QTc at baseline; only 18 (26.1%) patients had prolonged QTc after 48 hours. Baseline QTc was not associated with neurological outcome ($P = .27$). However, prolonged QTc after 48 hours was associated with worse mRS at discharge (4.5 [4.0-6.0] versus 2.0 [1.0-3.0]; $P < .0001$). Patients who deceased during hospitalization (n = 7 [10.1%]) as compared with survivors had more frequently prolonged QTc after 48 hours (38.9 versus 0%; $P < .0001$), higher level of hsTnI (48.4 [36.1-75.0] versus 8.6 [3.4-26.5]; $P = .003$), and BNP (334 [224-866] versus 109 [30-190]; $P = .014$). In univariate analysis, 1-year mortality was associated with prolonged QTc after 48 hours, hsTnI, and BNP. In multivariate analysis, only BNP remained to be associated with 1-year mortality (odds ratio 3.41, 95% confidence interval 1.06-11.03). *Conclusions:* QTc interval in patients with acute ischemic stroke is a dynamic parameter. Prolonged QTc after 48 hours, but not baseline QTc, correlated with neurological outcome and 1-year mortality. Patients with prolonged QTc had higher level of hsTnI.
Key Words: QTc interval prolongation—ischemic stroke—brain natriuretic peptide—high-sensitivity troponin I—mortality.

From the *Cardiology Department, Faculty of Medicine in Pilsen and Faculty Hospital, Charles University, Czech Republic; †Internal Department II, Faculty of Medicine in Pilsen, Charles University, Czech Republic; ‡Biomedical Centre, Faculty of Medicine in Pilsen, Charles University, Czech Republic; §Neurology Department, Faculty of Medicine in Pilsen, Charles University, Czech Republic; ‖Department of Imaging Methods, Faculty of Medicine in Pilsen, Charles University, Czech Republic; and ¶Department of Clinical Biochemistry and Hematology, Faculty Hospital in Pilsen, Czech Republic.

Received March 3, 2016; accepted August 5, 2016.

Grant Support: This research was supported by MH–DRO (Faculty Hospital in Pilsen—FNPl, 00669806) and by the Charles University Research Fund (project number P36).

Address correspondence to Jitka Seidlerová, MD, PhD, Department of Internal Medicine II, Faculty of Medicine in Pilsen, Charles University, Edvarda Beneše 13, 305 99 Plzeň, Czech Republic. E-mail: seidlerovaj@fnplzen.cz.

1052-3057/$ - see front matter

http://dx.doi.org/10.1016/j.jstrokecerebrovasdis.2016.08.005

ESC HEART FAILURE
ESC Heart Failure (2020)
Published online in Wiley Online Library (wileyonlinelibrary.com) **DOI:** 10.1002/ehf2.12917

ORIGINAL RESEARCH ARTICLE

Early rehabilitation after stroke: relationship between the heart rate variability and functional outcome

Nadja Scherbakov[1,2,3,4*†], Anush Barkhudaryan[5†], Nicole Ebner[6,7], Stephan von Haehling[6,7], Stefan D. Anker[1,2,8], Michael Joebges[9] and Wolfram Doehner[1,2,3,4]

[1]Berlin-Brandenburg Center for Regenerative Therapies (BCRT), Center for Stroke Research Berlin (CSB), Charité Universitätsmedizin Berlin, Berlin, Germany; [2]German Center for Cardiovascular Research (DZHK), partner site Berlin, Berlin, Germany; [3]Department of Cardiology, Charité–Universitätsmedizin Berlin, Berlin, Germany; [4]Center for Stroke Research Berlin (CSB), Charité–Universitätsmedizin Berlin, Berlin, Germany; [5]Department of Cardiology, Clinic of General and Invasive Cardiology, University Hospital No. 1, Yerevan State Medical University, Yerevan, Armenia; [6]Department of Cardiology and Pneumology, University Medical Center Göttingen (UMG), Göttingen, Germany; [7]German Center for Cardiovascular Research (DZHK), partner site Göttingen, Göttingen, Germany; [8]Division of Cardiology and Metabolism-Heart Failure, Cachexia and Sarcopenia, Department of Cardiology (CVK), Charité–Universitätsmedizin Berlin, Berlin, Germany; [9]Clinic for Neurology and Neurological Rehabilitation, Schmieder Clinic (Stiftung Co.) KG, Konstanz, Germany

Abstract

Aims Impaired autonomic nervous system regulation is frequently observed in patients with stroke. The aim of this prospective study was to evaluate the impact of cardiac autonomic tone on functional outcome after the early post-stroke rehabilitation.

Methods and results One hundred and three consecutive patients (67 ± 11 years, body mass index (BMI) 27.1 ± 5.4 kg/m^2, 64% men) with ischaemic (84% of patients) and haemorrhagic stroke were studied. Depressed heart rate variability (HRV), as a surrogate marker of increased sympathetic tone, was defined by the standard deviation of NN intervals < 100 ms and HRV triangular index ≤ 20 assessed from a 24 h Holter electrocardiogram at admission to rehabilitation (23 ± 16 days after stroke). Twenty-two per cent of patients had depressed HRV at baseline and were comparable with patients with normal HRV with regard to their functional [Barthel Index (BI), modified Rankin Scale (mRS), and Rivermead Motor Assessment (RMA)] and biochemical status. After a 4-week follow-up, 70% of patients with depressed HRV showed a cumulative functional disability, defined by mRS ≥ 4, BI ≤ 70, and RMA ≤ 5, in contrast to patients with normal HRV (35%, $P = 0.003$). Patients with depressed HRV showed a worse functional status by BI (−16%, $P < 0.001$), RMA (−12%, $P < 0.05$), and mRS (+16%, $P < 0.01$), compared with patients with normal HRV. Cumulative functional disability was associated with depressed HRV (odds ratio 4.25, 95% confidence interval 1.56–11.54, $P < 0.005$) after adjustment for age, sex, and body mass index (odds ratio 4.6, 95% confidence interval 1.42–14.97, $P < 0.05$).

Conclusions The presence of autonomic cardiovascular dysregulation in patients with subacute stroke was associated with adverse functional outcome after the early post-stroke rehabilitation.

Keywords Stroke; Heart rate variability; Rehabilitation; Functional outcome

Received: 11 June 2020; Revised: 8 July 2020; Accepted: 13 July 2020
**Correspondence to: Nadja Scherbakov, Department of Cardiology and Center for Stroke Research Berlin (CSB), Charité–Universitätsmedizin Berlin, Augustenburger Platz 1, Berlin 13353, Germany. Tel.: +49-30-450 560 363; Fax: +49-30-450 553 951. Email: nadja.scherbakov@charite.de*
†These authors contributed equally to the work.

Introduction

Stroke is a leading cause of disability in the adult age worldwide.[1] Early post-stroke rehabilitation plays an important role in recovery after stroke. A wide range of medical complications, including autonomic imbalance, characterized by decreased vagal modulation and increased sympathetic activation may influence the efficacy of rehabilitation efforts.[2,3] There is an evidence of cardiac dysfunction after clinical and experimental stroke.[4,5,6] A cardiac autonomic dysregulation, manifested by an impaired control of blood pressure and heart rate leading to cerebral hypoperfusion and secondary brain injury, may result in the increased susceptibility for post-stroke complications and contribute to an unfavourable functional outcome.[5,7,8] Previous studies have described the development of

NEUROLOGICAL RESEARCH
https://doi.org/10.1080/01616412.2020.1782103

Taylor & Francis
Taylor & Francis Group

ARTICLE

Check for updates

Relationship between ischemic stroke locations, etiology subtypes, neurological outcomes, and autonomic cardiac function

Mengxi Zhao[a], Ling Guan[a,b], Jean-Paul Collet[c,d] and Yilong Wang[d,e]

[a]Department of Neurology, Beijing Tiantan Hospital, Capital Medical University, Beijing, China; [b]National Clinical Research Center for Neurological Diseases, Beijing, China; [c]Department of Medicine, BC Children's Hospital Research Institute, University of British Columbia, Vancouver, Canada; [d]Advanced Innovation Center for Human Brain Protection, Capital Medical University, Beijing, China; [e]Department of Neurology, China National Clinical Research Center for Neurological Diseases, Beijing Tiantan Hospital, Capital Medical University, Beijing, China

ABSTRACT

Background: Post-stroke autonomic nervous dysfunction measured with heart rate variability (HRV) is correlated with the traditional risk factors and poor outcome. This study aimed to investigate the association between HRV and infarct locations, etiology subtypes, and neurological functional outcomes in patients with acute ischemic stroke (AIS).

Methods: In this prospective observational study, 186 consecutive patients were assigned to four major stroke severity categories based on the National Institutes of Health Stroke Scale score (NIHSS) and the modified Rankin Scale score (mRS): mild (NIHSS 0–4) stroke, moderate (NIHSS 5–14) stroke, 'favorable' (mRS 0–2) group, and 'unfavorable' (mRS 3–5) group. HRV time domain parameters were applied to evaluate the autonomic function of patients within 1 week after admission. All patients were classified into different etiology subtypes based on the TOAST (modified Trial of ORG 10172 in Acute Stroke Treatment) classification. The association of HRV with stroke location, etiology subtypes, neurological outcome was explored for all participants. Univariate and multivariate analyses were applied to explore the prediction value of HRV.

Results: 160 participants had large artery atherosclerotic infarction (LAA), 61 had right internal carotid artery system infarction (R-ICA), and 61 had vertebrobasilar artery system infarction (VB). Root-mean-square of differences (RMSSD) of adjacent RR intervals and the proportion calculated by dividing the interbeat interval differences >50 ms (pNN50) in patients of VB group was significantly lower than those of patients in R-ICA group ($P < 0.01$). HRV parameters in the LAA group was significantly lower than non-LAA group ($P < 0.01$). At discharge, significant lower HRV presented in the unfavorable group and moderate group ($P < 0.05$). After logistic univariate and multivariate analysis, lower SDNN (OR = 1.019; 95% CI = 1.003–1.035; p= 0.021) was independently associated with unfavorable mRS and higher NIHSS at discharge (OR = 1.013; 95%CI = 1.003–1.024; p= 0.015). Only SDNN showed predictive value for mRS≥3 (OR = 1.012; 95%CI = 1.002–1.022; p= 0.016) at 1 year.

Conclusions: HRV measured after admission is related to the AIS infarction basin, TOAST subtypes, and neurological outcomes at discharge suggesting a possible role for HRV in evaluating AIS and identifying high-risk patients.

ARTICLE HISTORY
Received 7 November 2019
Accepted 8 June 2020

KEYWORDS
Acute ischemic stroke; autonomic nervous dysfunction; heart rate variability; TOAST subtypes; infarct locations; neurological outcomes

Introduction

Abnormal autonomic cardiac function has been described after acute ischemic stroke (AIS). When stroke occurs, demands for the re-establishment of homeostasis may exceed the adaptive capacity of the autonomic nervous system (ANS) [1,2] with manifestations in different systems of the organism resulting from destabilizing the sympatho-vagal balance [2–4].

Measurement of heart rate variability (HRV) is an established and widely implemented tool for assessing ANS function [1]. It is generally known that risk factors for stroke include hypertension, hyperlipidemia, and hyperglycemia, and numerous studies have confirmed the relationship between the magnitude of these risk factors and outcome of stroke [5]. Several other studies have also confirmed that reduced HRV was associated with these risk factors and with the

CONTACT Yilong Wang yilong528@aliyun.com National Clinical Research Center for Neurological Diseases, Beijing Tiantan Hospital, Capital Medical University, Beijing, China; Ling Guan lguanm@hotmail.com National Clinical Research Center for Neurological Diseases, Beijing Tiantan Hospital, Capital Medical University, Beijing, China

Abbreviations: AIS: acute ischemic stroke; ANS: autonomic nervous system; HRV: heart rate variability; TOAST: the modified Trial of ORG 10172 in Acute Stroke Treatment; MRI: magnetic resonance imaging; CT: computed tomography; ECG: electrocardiogram; NIHSS: National Institutes of Health Stroke Scale; mRS: modified Rankin Scale; SDNN: standard deviation of all normal-to-normal RR intervals; RMSSD: root-mean-square of differences of adjacent normal-to-normal RR intervals; pNN50: the proportion that is calculated by dividing interbeat interval differences that are greater than 50 ms; LAA: large artery atherosclerotic infarction; CE: cardiogenic embolismic infarction; SOE: stroke of other demonstrated etiology; SUE: stroke of other undemonstrated etiology; SAO: small artery occlusion with lacunar infarction; L-ICA: left internal carotid artery; R-ICA: right internal carotid artery; VB: vertebrobasilar; B-ICA: bilateral internal carotid artery; OR: odds ratio; CI: confident interval.

Lampiran 2. Biodata Penulis

CURRICULUM VITAE

IDENTITAS DIRI

Nama Lengkap	: Dhiya Lathifah Faisal
Nama Panggilan	: Dhiya
TTL	: Jakarta, 02 Februari 1999
Jenis Kelami	: Perempuan
Agama	: Islam
Alama	: BTP Blok B No. 264, Tamalanrea, Kota Makassar, Sulawesi Selatan
No.Hp	: 082124310831
E-mail	: dhiyalathifah.work@gmail.com
Suku	: Bugis
Kewarganegaraan	: Indonesia

RIWAYAT PENDIDIKAN

2005 – 2011	: SDN 13 Pagi Jakarta Timur
2011 – 2014	: SMP Negeri 92 Jakarta
2014 – 2017	: SMA Negeri 68 Jakarta
2017 – sekarang	: Jurusan Pendidikan Dokter Umum, Fakultas Kedokteran, Universitas Hasanuddin

RIWAYAT ORGANISASI

2018 – sekarang	: Himpunan Mahasiswa Islam Fakultas Kedokteran Unhas
2018 – sekarang	: Medical Muslim Family Fakultas Kedokteran Unhas
2018 – 2020	: Roentgent Photography Fakultas Kedokteran Unhas
2020 – sekarang	: Anggota Kementerian Pengembangan Minat dan Bakat BEM KEMA FK UNHAS