National Journal of Physiology, Pharmacy and Pharmacology

RESEARCH ARTICLE

Power spectral analysis of cardiovascular autonomic functional modulation in response to acute psychological stress after induction of acupressure at GV20: An observational study

Nagalakshmi Vijaykumar, Vandana C Kattimani, Shobha C Nallulwar, S L Karne

Department of Physiology, Sri Dharmasthala Manjunatheshwara Medical College, Dharwad, Karnataka, India

Correspondence to: Nagalakshmi Vijaykumar, E-mail: drlakshmi26@yahoo.com

Received: November 10, 2016; **Accepted:** December 02, 2016

ABSTRACT

Background: Acupressure is a simple, non-invasive, painless method which can be complementary and alternative medicine treatment to reduce stress. Acupressure at GV-20 provides the relief of anxiety and acute stress. **Aims and Objectives:** Evaluate the effect of GV20 Acupressure on cardiac autonomic functional modulation using heart rate variability (HRV). **Materials and Methods:** This is a cross-sectional study to investigate the use of an acupressure in acute stress reduction in adults ($n = 30$). Mental arithmetic stress was administered before and after acupressure. Acupressure was given at GV20 for 5 min, and HRV was measured. The collected data were analyzed for frequency domain using non-parametric method of Fast Fourier Transform, using Ku-bios HRV analysis software. **Results:** All interventions were associated with the following changes, during stress after acupressure compared to stress before acupressure: Significant increase of total power ($P \leq 0.05$), decrease in low frequency (LF), and increase in high frequency (HF) and decrease in LF/HF value. Changes during rest after acupressure and before acupressure are as follows: Decrease in total power, increase in LF, decrease in HF, and decrease in LF/HF but not significant ($P \geq 0.05$). **Conclusion:** Thus, this study indicates that acupressure at GV20 was able to reduce stress in the subjects significantly. This positive finding suggests that acupressure may have a role in reducing acute psychological stress in young adults and help in improving performance.

KEY WORDS: Autonomic Imbalance; Complementary Medicine; Stress; Acupuncture; GV20

INTRODUCTION

"Health is Wealth" is one of the golden thoughts in the society. In today's society, stress is one of the common physiological states seen at all ages. While stress is adaptive in some situations, chronic stress can be detrimental to physical health and mental well-being.[1,2] College students often experience considerable stress and finding a treatment to reduce the stress response could be particularly beneficial to this population.[3] Acupressure is a complementary and alternative medicine treatment in which fingertip pressure is applied to acupoints, points on the skin designated as such by Traditional Chinese Medicine.[4]

The previous studies have suggested that acupressure may reduce stress and anxiety in medical settings.[5-8] Studies with healthy participants have also found acupressure to reduce subjective stress levels.[9] Although the exact mechanism underlying these effects is unknown, it has been hypothesized that acupressure may affect the autonomic nervous system (ANS); acupressure may be a promising treatment for stress as it is portable, non-pharmacological, and can be taught to the novice user.

Access this article online	
Website: www.njppp.com	Quick Response code
DOI: 10.5455/njppp.2017.7.1131402122016	

Pressure on the well-defined specific points located on the body surface called as acupoints results in activation at these points. GV20, GV21, GV19, GB21, GB22, GB18, CV20, CV18, and CV21 are some of the examples of acupoints located in different areas of the body and have specific effects on activation.[10] Role of acupressure at PC6, HT7 and extra1 in relieving acute stress have been already studied and proved.[11,12] Among all the points in the body, GV20 (BAIHUI) is the most important point. It is described as the meeting point of all the meridians in the body.[10] Pressure at GV-20 is described to have effect on balancing of energy channels which improve concentration, memory and this point is used in neurology and psychiatry. According to the studies made by magnetic resonance imaging (MRI), it is proved situated in the frontal lobe area. Stimulation of the GV20 acupoint mainly provide the relief of headache, stroke, dizziness, anxiety, acute stress, and also helps in enhancing the nitric oxide generation and increases the local circulation.[10]

During normal resting condition, there is a balance between the sympathetic and parasympathetic divisions of autonomic activities (Sympathovagal balance) which is responsible for the normal heart rate (HR), blood pressure (BP), and HR variability (HRV) which is variation in R-R interval during normal respiration.[13] During stress, there is increased sympathetic discharge as well as withdrawal of parasympathetic activity which results in altered these cardiovascular parameters.[14]

Frequency domain measurements got by power spectral analysis (PSA) of HRV can quantify both sympathetic and parasympathetic components of ANS and recognize sympathovagal imbalance. The analysis of variations in heart rate (HRV) has also been used to determine the balance between sympathetic and vagal nerve activities in the heart.[13] Experimentally, the acute mental stress can be induced by implementation of mental arithmetic subtraction test, and the effects can be studied by recording blood pressure, HR, and HRV.

We hypothesized that acupressure at GV 20 will have beneficial effect on cardiovascular parameters which are altered during acute mental stress. The effect of acupuncture at various points is already studied but it is an invasive procedure. The effect of acupressure at GV 20 on HRV during acute mental stress is not studied in young adults.

MATERIALS AND METHODS

This is a cross-sectional study conducted in the Department of Physiology, SDM Medical College from July to September 2015 after obtaining institutional ethical clearance, on 30 healthy volunteers of 18-20 years age of both the genders (males - 18 and females - 12), those who were not familiar with acupressure were selected as subjects randomly. The subjects explained regarding the procedure and written informed consent were taken.

Exclusion Criteria

The smokers, past history of psychiatric illness, body mass index (BMI, in kg/m^2) outside the range of 18.5-24.99, subjects currently using steroid hormone medications and/or recreational drugs were excluded from the study.

Study Design

Subjects were instructed not to have coffee, tea or cola 12 h before the test. They were asked to come to the physiology laboratory at 9 am after having a light breakfast. Sociodemographic details were taken on a standard pro forma. Subjects rested quietly in the supine position, in a silent and semidark room for 20 min. HRV analysis was performed using electrocardiogram (ECG) recorded at rest in using lead II in supine position for 5 min. ECG recorded using disposable Ag/AgCl electrodes. ECG data in standard lead II configuration acquired using portable ECG data acquisition equipment (Niviqure Meditech Systems, Bengaluru, India). Frequency domain analysis was performed using non-parametric method of Fast Fourier Transform, using Kubios HRV analysis software. In the frequency domain, following values were recorded; (1) very low frequency power, defined as the power ≤0.04 Hz; (2) low frequency power, the power between the 0.04 to 0.15 Hz; (3) high frequency power, the power between the 0.15 and 0.40 Hz; (4) total spectral power, the power between the 0.0 and 0.40 Hz were measured. Measurement LF and high frequency (HF) power components were presented in absolute values of power (ms^2) and (nu). Mental stress was induced by arithmetic mental challenge under time pressure. The subjects were asked to rapidly subtract 7 from a three- or four-digit number, depending on the participant's skill level. During acute mental stress HRV recorded. After this, acupoint GV-20 was located on the scalp by joining tips of both ears and taking midpoint of this line. Acupressure was given at this point with middle finger with circular movement at 20-25 cycles per min for 5 min.[6] Resting ECG after acupressure was recorded for 5 min in a similar procedure as explained. Again the acute mental stress was given in the same way for 5 min, during which HRV was recorded.

Statistical Analysis

It is a cross-sectional study conducted to assess the cardiovascular autonomic functional modulation in response to acute mental stress after induction of acupressure at GV20. Statistical analysis was performed using SPSS software version 20. Comparison of the data between rest findings and during mental stress before and after acupressure was done by student paired t-test. Values were expressed as mean ± standard deviation (SD). $P < 0.05$ was considered as statistically significant and <0.01 as highly significant.

RESULTS

It is a cross-sectional study done to assess the cardiovascular autonomic functional modulation in response to acute mental stress after induction of acupressure at GV20. Values were expressed as mean + SD. $P < 0.05$ was considered as statistically significant and <0.01 as highly significant. Table 1 shows the demographical characteristics of the subjects. There are 30 subjects ($n = 30$) which includes both gender (Male= 18, Female=12) of mean age group of 18.56 ± 0.10 years.

Table 2 shows frequency domain indices of HRV during rest and stress before acupressure. ($n = 30$). There is a significant reduction in Total power during stress when compared to rest ($P = 0.012$). There is also significant reduction in HF (ms^2) during stress ($P = 0.005$) and HF% during stress ($P = 0.015$). HF (nu) is decreased but not significant. LF (ms^2) is decreased during stress. LF (nu) and LF% is increased during stress compared to rest but it is not significant. LF/HF is increased during stress compared to rest.

Table 3 shows the PSA of frequency domain HRV parameters during rest and stress after Acupressure. There is reduction in the total power during stress, but not significant. LF (nu) is increased; HF (nu) is decreased during stress which is not significant. There is reduction in LF (ms^2) as well as in HF (ms^2), which is not significant. There is increase in LF/HF in stress compared to rest, which is not significant.

Table 4 shows PSA of frequency domain HRV parameters during rest before and after Acupressure. Total power is increased during rest after acupressure compared to rest before acupressure but it is not significant. LF (nu), LF (ms^2), is increased during rest after acupressure compared to rest before acupressure. HF (ms^2) is increased during rest after acupressure compared to rest before acupressure but it is not significant.

Table 5 shows PSA of frequency domain HRV parameters during stress before and after Acupressure. Total power is significantly increased during stress after acupressure as compared to stress before acupressure ($P = 0.015$). Even LF (ms^2) is significantly increased during stress after acupressure ($P = 0.032$). LF (nu) is decreased during stress after acupressure compared to stress before acupressure. HF (ms^2), HF (nu), is increased during stress after acupressure compared to stress before acupressure. LF/HF is decreased during stress after acupressure.

Table 1: The demographical characteristics of subjects. (n=30)

Parameters	Mean±SD
Age (years)	18.56±0.10
Height (cm)	158.30±1.85
Weight (Kg)	60.36±2.24
BMI (Kg/m^2)	22.08±0.76

SD: Standard deviation, BMI: Body mass index

Table 2: PSA of frequency domain HRV parameters during rest and stress before acupressure. (n=30)

Parameter	Rest	Stress	t value	*P*
Total power (ms^2)	1895.33±253.89	1258.06±124.06	2.692	0.012*
LF (nu)	42.0099±2.86002	48.65558±2.94851	−1.898	0.068
HF (nu)	77.5036±20.29499	51.1540±2.93836	1.264	0.216
LF/HF	0.9006±0.12084	1.3502±0.20908	−1.963	0.059
LF (ms^2)	625.3290±100.708	425.9690±45.83956	1.959	0.060
HF (ms^2)	849.2053±132.92	493.79±73.047	3.012	0.005*

Values expressed as mean±SEM. Lf: Low frequency, HF: High frequency, $P<0.05$ considered as significant *, PSA: Power spectral analysis, HRV: Heart rate variability

Table 3: PSA of frequency domain HRV parameters during rest and stress after acupressure. (n=30)

Parameters	Rest	Stress	t value	*P*
Total power (ms^2)	4592.00±2649.16	2990.90±653.63	0.576	0.569
LF (nu)	42.52±2.51	47.70±2.77	−1.537	0.135
HF (nu)	57.06±2.49	52.42±2.99	1.300	0.204
LF/HF	0.80±0.08	1.11±0.13	−2.072	0.047
LF (ms^2)	1309.73±515.21	942.19±216.69	0.649	0.521
HF (ms^2)	3546.30±1839.74	1206.58±413.34	1.241	0.224

Values expressed as mean±SEM. LF: Low frequency, HF: High frequency, *$P<0.05$ considered as significant, PSA: Power spectral analysis, HRV: Heart rate variability

DISCUSSION

This study was conducted to observe the cardiovascular autonomic functional modulation in response to acute psychological stress after induction of acupressure at GV20. Table 2 shows LF (nu) is increased and HF (nu) is decreased and LF/HF is increased during stress compared to rest before acupressure. Our study shows that there is increase in sympathetic and decrease in parasympathetic discharge during stress compared to rest before acupressure. Similar effects are recorded by Skinbuiewski et al., Filarier showing significantly increased LF/HF, decrease in HF component indicating the stress.[15,16]

Table 2 shows LF (nu) is increased and HF (nu) is decreased at stress compared to rest after acupressure demonstrating increased sympathetic and decreased parasympathetic discharge during stress even after acupressure. We also compared HRV parameters during rest and stress before and after acupressure. We observed that total power is increased during rest after acupressure compared to before acupressure. This can be due to either increase in LF power indicating

Table 4: PSA of frequency domain HRV parameters during rest before and after acupressure. (*n*=30)

Parameters	Rest (before acupressure)	Rest (after acupressure)	t value	*P*
Total power (ms^2)	1895.33±253.89	4592.00±2649.16	−1.006	0.323
LF (nu)	42.00±2.86	42.52±2.51	−0.131	0.896
HF (nu)	77.50±20.29	57.06±2.49	0.975	0.338
LF/HF	0.90±0.12	0.80±0.08	0.630	0.533
LF (ms^2)	625.32±100.70	1309.73±515.21	−1.357	0.185
HF (ms^2)	849.20±132.92	3546.30±1839.74	−1.445	0.159

Values expressed as mean±SEM. LF: Low frequency, HF: High frequency, **P*<0.05 considered as significant, PSA: Power spectral analysis, HRV: Heart rate variability

Table 5: PSA of frequency domain HRV parameters during stress before and after acupressure. (*n*=30)

Parameters	Stress (before acupressure)	Stress (after acupressure)	t value	*P*
Total power (ms^2)	1258.06±124.01	2990.90±653.63	−2.579	0.015*
LF (nu)	48.65±2.94	47.70±2.77	0.261	0.796
HF (nu)	51.15±2.93	52.42±2.990	−0.331	0.743
LF/HF	1.35±0.20	1.11±0.13	1.010	0.321
LF (ms^2)	425.96±45.83	942.19±216.69	−2.258	0.032*
HF (ms^2)	493.79±73.04	1206.58±413.34	−1.701	0.100

Values expressed as mean±SEM. LF: Low frequency, HF: High frequency, **P*<0.05 considered as significant, PSA: Power spectral analysis, HRV: Heart rate variability

sympathetic stimulation due to apprehension related to procedure or due to increases in HF power due to activation of parasympathetic by acupressure.

Normally during any acute mental stress, there is increased sympathetic and decreased parasympathetic discharge.[15] We observed that in response to stress after acupressure there was a significant increase in total power indicating cardiac autonomic modulation. There was also increase in HF (nu) and decrease in LF (nu) suggesting increased parasympathetic and decreased sympathetic discharge in response to stress.

As in stress, there is decrease in parasympathetic system; but after acupressure, there is increase in parasympathetic activity which is responsible for increased total power. LF (nu) is decreased HF (nu) is increased LF/HF is decreased during stress after acupressure but it is not significant. Arai et al. observed that acupuncture at EX-1 reduces LF/HF indicating reduction in sympathetic activity.[12] As GV20 acupoint and acupressure was given at the similar points the result corroborated with above study. Sparrow et al. observed increased parasympathetic activity after acupuncture using HRV in hypertensive patients.[17]

Postulated Mechanism

Our study shows that parasympathetic system is activated during stress after acupressure. Evidence from acupuncture research indicates manual stimulation of acupoints produces endogenous opioids which increase the production of neurotransmitters such as serotonin, GABA and regulates cortisol. These changes have effect on the midbrain structures to reduce the pain, heart rate, anxiety, and induce peace of mind.[18] Acupressure also produces internal opioids such as endorphins which reduce pain, stress and slow down heart rate. Several f MRI neuroimaging studies have noted that during acupuncture there is decreased activity of limbic system, amygdala and midbrain structures involved in alert response during stressful conditions leading to reduced heart rate.[18]

From this study, we prove that acupressure has calming effect during acute mental stress. This effect is mainly brought about by activation of parasympathetic nervous system. This study is important as acupressure for 5 min at GV 20 can be suggested to the students before their examination. It may help by reducing their anxiety and improve their cognitive function, memory and thereby performance during the examination. Less sample size is one of the limitations of our study.

CONCLUSION

Acupressure is the simple, non-invasive, painless method which is followed by many people worldwide for various indications such as headache, stress, pain, asthma, and migraine. It has a significant effect in reducing the stress level and building up the positive energy level and reducing the heart rate and BP. In acute stress, sympathetic discharge is more, but after acupressure, it is seen along with sympathetic, parasympathetic system is also activated which helps in reducing the heart rate, BP and stress level. Thus, it can be said that acupressure could be able to improve the performance

level and overcome stress. This study would be a leading pathway to study the effect of acupressure on different health conditions compared to acupuncture which is invasive. This will also help to improve stress-related decreased performance in students especially medical students.

ACKNOWLEDGMENT

We would like to express our gratitude toward Indian Council of Medical Research for the support to conduct the study. We also like to express our gratitude to whole department of Physiology, SDMCMS and H Dharwad for their support to conduct the study.

REFERENCES

1. Hellhammer J, Schubert M. The physiological response to Trier Social Stress Test relates to subjective measures of stress during but not before or after the test. Psychoneuroendocrinology. 2012;37(1):119-24.
2. Lagraauw HM, Kuiper J, Bot I. Acute and chronic psychological stress as risk factors for cardiovascular disease: Insights gained from epidemiological, clinical and experimental studies. Brain Behav Immun. 2015;50:18-30.
3. Kumar M, Sharma S, Gupta S, Vaish S, Misra R. Effect of stress on academic performance in medical students – a cross sectional study. Indian J Physiol Pharmacol. 2014;58(1):81-6.
4. Hsu CC, Weng CS, Sun MF, Shyu LY, Hu WC, Chang YH. Evaluation of scalp and auricular acupuncture on EEG, HRV, and PRV. Am J Chin Med. 2007;35(2):219-30.
5. Hmwe NT, Subramanian P, Tan LP, Chong WK. The effects of acupressure on depression, anxiety and stress in patients with hemodialysis: A randomized controlled trial. Int J Nurs Stud. 2015;52(2):509-18.
6. Kwan RY, Leung MC, Lai CK. Acupressure for agitation in nursing home residents with dementia: Study protocol for a randomized controlled trial. Trials. 2014;15:410.
7. Ferreira DC, De Rossi A, Torres CP, Galo R, Paula-Silva FW, Queiroz AM Effect of laser acupuncture and auricular acupressure in a child with trismus as a sequela of medulloblastoma. Acupunct Med. 2014;32(2):190-3.
8. Hsieh LL, Liou HH, Lee LH, Chen TH, Yen AM. Effect of acupressure and trigger points in treating headache: A randomized controlled trial. Am J Chin Med. 2010;38(1):1-14.
9. McFadden KL, Healy KM, Hoversten KP, Ito TA, Hernández TD. Efficacy of acupressure for non-pharmacological stress reduction in college students. Complement Ther Med. 2012;20(4):175-82.
10. Shen EY, Chen FJ, Chen YY, Lin MF. Locating the acupoint baihui (GV20) beneath the cerebral cortex with MRI reconstructed 3D neuroimages. Evid Based Complement Alternat Med. 2011;2011:362494.
11. Chang S, Chao WL, Chiang MJ, Li SJ, Lu YT, Ma CM, et al. Effects of acupuncture at Neiguan (PC 6) of the pericardial meridian on blood pressure and heart rate variability. Chin J Physiol. 2008;51(3):167-77.
12. Arai YC, Ushida T, Osuga T, Matsubara T, Oshima K, Kawaguchi K, et al. The effect of acupressure at the extra 1 point on subjective and autonomic responses to needle insertion. Anesth Analg. 2008;107(2):661-4.
13. Heart rate variability. Standards of measurement, physiological interpretation, and clinical use. Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology. Eur Heart J. 1996;17(3):354-81.
14. Lucini D, Di FG, Parati G, Pagani M. Impact of chronic psychosocial stress on autonomic cardiovascular regulation in otherwise healthy subjects. Hypertension. 2005;46(5):1201-6.
15. Skibniewski FW, Dziuda L, Baran PM, Krej MK, Guzowski S, Piotrowski MA, et al. Preliminary results of the LF/HF ratio as an indicator for estimating difficulty level of flight tasks. Aerosp Med Hum Perform. 2015;86(6):518-23.
16. Filaire E, Portier H, Massart A, Ramat L, Teixeira A. Effect of lecturing to 200 students on heart rate variability and alpha-amylase activity. Eur J Appl Physiol. 2010;108(5):1035-43.
17. Sparrow K, Golianu B. Does acupuncture reduce stress over time? A clinical heart rate variability study in hypertensive patients. Med Acupunct. 2014;26(5):286-94.
18. James R. The neurochemistry of counter conditioning: Acupressure desensitization in psychotherapy. Energy Psychol. 2009;1:1-4.

How to cite this article: Vijaykumar N, Kattimani VC, Nallulwar SC, Karne SL. Power spectral analysis of cardiovascular autonomic functional modulation in response to acute psychological stress after induction of acupressure at GV20: An observational study. Natl J Physiol Pharm Pharmacol 2017;7(4):366-370.

Source of Support: Nil, **Conflict of Interest:** None declared.