EFFECT OF MUSIC EXPOSURE ON HEART RATE VARIABILITY

Sneha M. Bhatkar *, Surendra S. Shivalkar Sachin H. Mulkutkar*****

*Assistant Professor, **Professor, ***Professor and Head, Department of Physiology, Grant Government Medical College, Mumbai – 400008.

ABSTRACT: Introduction and Objectives: Music is universal and part of almost every culture. Heart rate variability (HRV) is a non-invasive tool for the assessment of cardiac autonomic control. Music may be helpful as a therapeutic measure in ANS disturbances associated with emotional or psychological disorders (e.g. Anxiety, Stress) by modulating the ANS. Research on potential beneficial effects of music on hypothalamo-pituitary axis functioning has been established and significant positive changes were noted. This study was conducted to evaluate effects of music exposure on heart rate variability. **Material and Methods:** The present study was of cross sectional type consisting of 50 subjects of both sexes between 18 to 30 years of age. The selected subjects were clinically healthy with no known history of any chronic disorders, prolonged medication or addiction. Subjects were exposed to music with the help of headphones. HRV recording and analysis was done with the help of Medicaid Physiopac and Kubois Software version 2.1. HRV was recorded before and after exposure to 30 minutes of self-chosen, soft music and analysed statistically by Paired T test. **Results:** The present study showed that the time domain indices of HRV were significantly increased, frequency domain indices of HRV i.e. Low frequency (LF) and LF/HF ratio were significantly reduced and High frequency (HF) was significantly increased on exposure to music. (Paired T Test) **Conclusion:** Exposure to music affects heart rate variability and music exposure increases parasympathetic activity at the same time decreasing sympathetic activity.

Key words: Music, Low frequency, High frequency, LF/HF ratio, Heart rate variability

Abbreviations: HRV, Heart Rate Variability; LF, Lower Frequency; HF, High Frequency;

Author for Correspondence: Dr. Sneha M. Bhatkar, Assistant Professor, Department of Physiology, Grant Government Medical College, Mumbai - 400008. Email – snehabhatkar6353@gmail.com

INTRODUCTION

Since ancient and medieval times music has been part of people's lives in pain, sorrow and happy occasions. Previous investigations found reductions in perceived levels of psychological stress, increased coping abilities or altered levels in perceived relaxations after listening to music in context of stressful situation [1,2]. The most extensive account of music in general hospitals appeared during the first of the 19th century when health care practitioners used music in conjunction with anaesthesia and analgesia [3]. In 1914, Kane was the first person to provide intra-operative music to distract patients from the horrors of surgery [4].

Heart rate variability (HRV) is a non-invasive tool for the assessment of cardiac autonomic control [5]. In a normal heart with an intact autonomic nervous system (ANS) there will be continuous physiological variations of sinus cycles reflecting a balanced sympathovagal state and a normal HRV [6]. Heart rate variability is generally assessed based on time-domain or frequency-domain analysis. Low frequency (LF) reflects the interaction of both sympathetic and parasympathetic nervous system whereas high frequency (HF) reflects solely the activity of the parasympathetic nervous system and LF/HF ratio is accepted as an indicator of sympathovagal balance[7]. Time domain indices of HRV analysis are derived from either direct RR interval measurements or the differences between successive RR intervals [7]. Parameters of time-domain analysis include : RR – time interval between two successive heart beats, RMSSD - the square root of the mean squared differences of the successive NN intervals, NN50 - Number of intervals greater than 50 ms, pNN50 - Proportion of differences in consecutive NN interval, TINN - Triangular interpolation of RR intervals, all reflecting parasympathetic activity.

The literature demonstrated that auditory stimulation with music is known to induce many psychological responses [8,9,10]. Study done by Okada K suggested that RMSSD, pNN50, and HF were significantly increased whereas LF/HF was slightly decreased by music therapy in elderly patients with dementia and cerebrovascular disease [11]. Whereas do Amaral JA in their study showed that heavy-metal and baroque musical auditory stimulation at lower intensities acutely reduced global modulation of the heart and only heavy-metal music reduced HRV at higher intensities [12].

Present study was conducted to evaluate effects of music exposure on various parameters of heart rate variability in normal healthy subjects.

STUDY DESIGN

The study design involved 50 subjects of both sexes between 18 to 30 years of age. The selected subjects were clinically healthy with no known history of smoking, cardiovascular, respiratory or any other known neurological disease, diabetes, thyroid or any other endocrinological disorder, without any addiction and were not on any long term medications like AKT or ART.

MATERIALS AND METHODS

The present study was a cross sectional type of study conducted in the Department of Physiology in Grant Government Medical College & Sir J.J. Group of Hospitals, Mumbai.

The subjects were asked to refrain from ingesting any beverages containing caffeine and alcohol for at least 12 hours prior to the study. They were asked to report between 10 a.m to 12 p.m. in the lab after an adequate night's sleep followed by light breakfast. The subject was allowed to relax on a bed in supine position for 10 minutes and then ECG recording was done for 5 minutes in supine position using "Physiopac" by "Medicaid". After this subjects were asked to hear their self-chosen, soft music through headphones for the duration of 30 minutes. Followed by this again ECG recording was done for 5 minutes in supine position using Physiopac. ECG recording was done only after respiratory rate became regular and smooth at both times.

The recordings of ECG of all subjects were done by the same person in order to avoid any inter-observer error. Data collected on Physiopac was analysed by Kubois software, Version 2.1. We followed the recommendations set by the Task Force Guidelines established by European Society of Cardiology and the North American Society of Pacing and Electrophysiology [7]. Following visual examination of the ECGs, only stable and artifact free recordings with normal sinus rhythm were included in the analysis. HRV analysis of ECG of the subjects was done by blinding of the data analyst until the entire analysis was completed.

The data was expressed in terms of mean and standard deviation and statistics was determined using Paired T test. Statistical significance was tested at 5% & expressed in terms of 'p' value with $p<0.05$ as statistically significant.

RESULTS

Table 1 : Frequency domain indices of HRV before and after music exposure & Statistical analysis using Paired T test

Parameters	Before music (MEAN± S.D)	After music (MEAN± S.D)	P value	Paired T Test
LF(n.u.)	74.84±5.64	66.08±7.33	<0.0001	Statistically Significant
HF(n.u.)	25.16±5.64	33.90±7.35	<0.0001	Statistically Significant
LF/HF Ratio	3.15±0.87	2.09±0.73	<0.0001	Statistically Signific

				ant

(HR – heart rate, LF – low frequency, HF – High frequency, n.u. – normalised units)

Table 1 shows that frequency domain indices of HRV i.e. LF and LF/HF ratio were reduced and HF was increased on exposure to music and the difference was found to be statistically significant by paired T test.

Table 2 : Time domain indices of HRV before and after music exposure & Statistical analysis using Paired T test

Parameters	Before music (MEAN± S.D)	After music (MEAN± S.D)	P value	Paired T Test
Mean RR (ms)	734.78± 73.27	781.32± 83.2	<0.0001	Statistically Significant
RMSSD(ms)	16±3.12	21.62±6.02	<0.0001	Statistically Significant
NN50	4.78±1.98	10±5.36	<0.0001	Statistically Significant
pNN50(%)	2.43±1.33	5.22±2.96	<0.0001	Statistically Significant
TINN	113.19± 22.1	139.76± 25.72	<0.0001	Statistically Significant

(RR – time interval between two successive heart beats, RMSSD - the square root of the mean squared differences of the successive NN intervals, NN50 - Number of intervals greater than 50 ms, pNN50 - Proportion of differences in consecutive NN interval, TINN - Triangular interpolation of RR intervals)

Table 2 shows that time domain indices of HRV viz mean RR, RMSSD, NN50, pNN50 and TINN were increased on exposure to music and the difference was found to be statistically significant by paired T test.

DISCUSSION

The present study shows that time domain parameters of HRV viz mean RR, RMSSD, NN50, pNN50 and TINN were significantly increased on exposure to music. Similarly frequency domain indices of HRV i.e. LF and LF/HF ratio were significantly reduced and HF was significantly increased on exposure to music. Our results are indicative of decreased sympathetic activity and increased parasympathetic activity after music exposure.

Our study is in accordance with White JM who showed that listening to music increases the parasympathetic activity decreasing heart rate and increasing HRV [13]. It is also in accordance with Knight et al who observed that listening to music increases HF components of HRV and thus exerts direct physiological effects through the autonomic nervous system [14].

On the other hand Roque AL in their study showed that relaxant baroque and excitatory heavy metal music slightly decrease global heart rate variability because of the equivalent sound level [15]. Also da Silva AG et al observed that music with different tempos does not influence cardiac autonomic regulation in men [16]. Similarly Veternik M concluded that sounds have no impact on the heart rate variability and cardiac autonomic regulation [17].

The musical preferences of individuals are an important factor in the effect of music on them. In their study Lee D et al showed that providing self-selected music to day procedure patients in the preprocedure period helps in the reduction of physiological parameters and anxiety [18]. Also classical music exposure increases heart rate variability, whereas noise or rock music exposure decreases heart rate variability [19]. Thus we have included self-chosen soft music in our study.

Chalmers JA et al showed that Anxiety disorders are associated with reduced HRV [20]. Anxiety disorders also increases the risk of cardiovascular diseases three to fourfold [21]. Sloan RP et al in their study revealed significant effects of individual differences, stress, and physical position on RR interval, with increases in stress associated with decreases in RR interval [22]. They observed that HF power was significantly lower and the LF/HF ratio significantly higher in the standing compared with the sitting position. They also showed that psychological stress was significantly associated with an increase in the LF/HF ratio, suggesting increases in the relative predominance of sympathetic nervous system activity during stressful periods of the day.

Going further Tan DJA et al in their study showed that perioperative music listening significantly reduces psychological distress of anxiety and depression in patients [23]. Also McCraty et al suggested that positive emotions arising from listening to music may lead to alterations in HRV, which may be beneficial in the treatment of hypertension and in reducing the likelihood of sudden death in patients with congestive heart failure and coronary artery disease[24]. Lee et al examined the impact of music listening on the HRV in anxious patients waiting for medical help and found that after the musical intervention there was increase in HF and decrease in the LF and LF/HF ratio of HRV due to increase in the parasympathetic tone[25]. Thus by correlating other studies we can say that music can be used to reduce anxiety.

CONCLUSION

Our study shows that music has a role in modulating heart rate variability by increasing parasympathetic activity and decreasing sympathetic activity. Thus listening to self-chosen, soft music may be effective in reducing anxiety and stress.

REFERENCES

1. Jason Burns, Elise Labbé, Kathryn Williams, McCall J. Perceived and Physiological Indicators of Relaxation: As Different as Mozart and Alice in Chains. Applied Psychophysiology and Biofeedback.1999:24:(3):197-202.
2. Allen K, Golden LH, Izzo JL Jr, Ching MI, Forrest A, Niles CR, Niswander PR, Barlow JC. Normalization of hypertensive responses during ambulatory surgical stress by perioperative music.Psychosom Med.2001:63(3):487-92.
3. Taylor DB. Music in general hospital treatment from 1900 to 1950. J Music therapy. 1981:18(2)62-73.
4. Kane E. The Photograph in operating room. JAMA. 1914;62:1829-1830.
5. Kleiger RE, Stein PK, Bosner MS, Rottman JN. Time domain measurement of heart rate variability. In: Malik M, Camm AJ eds. Heart rate variability. Futura Armonk, New York. 1995:33-45.
6. Ravenswaaij VA, Kollee LAA, Hopman JCW, Stoelinga GBA and Van Geijn HP. Heart rate variability. Annals of International Journal of Medicine. 1993;331:574-578.
7. Task force of the European Society of Cardiology, and the North American Society of Pacing and Electrophysiology; Heart rate variability; Standards of measurement, physiological interpretation and clinical use. Circulation. 1996;93:1043-1065.
8. Klonari D, Pastiadis K, Papadelis G, Papanikolaou G. Loudness assessment of musical tones equalized in A-weighted level. Archives of Acoustics. 2011;36(2):23950.
9. Beauchamp JW. Perceptually correlated parameters of musical instrumenttones. Archives of Acoustics. 2010;36(2):225-38.

10. Kamisin´ ski T, Burkot M, Rubacha J, Brawata K. Study of the effect of theorchestra pit on the acoustics of the Krako´w Opera Hall. Archives ofAcoustics. 2009;34(1):481-90.
11. Okada K., Kurita A., Takase B. Effects of music therapy on autonomic nervous system activity, incidence of heart failure events, and plasma cytokine and catecholamine levels in elderly patients with cerebrovascular disease and dementia. Int Heart J. 2009;50:95–110
12. do Amaral JA, Guida HL, de Abreu LC, Barnabé V, Vanderlei FM, Valenti VE. Effects of auditory stimulation with music of different intensities on heart period. J Tradit Complement Med. 2015 Jan 7;6(1):23-8.
13. White JM. Effects of relaxing music on cardiac autonomic balance and anxiety after acute myocardial infarction. Am J Crit Care. 1999;8:220-230.
14. Knight W.E. and N.S. Ricard. Relaxing music prevents stress induced increase in subjective anxiety and systolic blood pressure and heart rate in healthy males and females, J Music Therapy. 2001:38:254-272.
15. Roque AL, Valenti VE, Guida HL, et al. The effects of auditory stimulation with music on heart rate variability in healthy women. Clinics (Sao Paulo). 2013;68(7):960-967.
16. da Silva Ag, Guida Hl, Antônio Am, Marcomini Rs, Fontes Am, Carlos De Abreu L et al. An exploration of heart rate response to differing music rhythm and tempos. Complement Ther Clin Pract. 2014;20 (2):130-134.
17. Veternik M, Tonhajzerova I, Misek J, Jakusova V, Hudeckova H, Jakus J, The impact of sound exposure on heart rate variability in adolescent students. Physiol Res. 2018;67(5):695-702.
18. Lee D, Henderson A and Shum D. The effect of music on preprocedure anxiety in Hong Kong Chinese day patients. Journal of clinical nursing. 2004:13(3):297-303.
19. Chuang, C.Y., W.R. Han, P.C. Li and S.T. Young, Effects of music therapy on subjective sensations and heart rate variability in treated cancer survivors: A pilot study. Complement Ther Med. 2010;18: 224-226.
20. Chalmers JA, Quintana DS, Abbott MJ, Kemp AH. Anxiety Disorders are Associated with Reduced Heart Rate Variability: A Meta-Analysis. Front Psychiatry. 2014;5:80. Published 2014 Jul 11
21. Vogelzangs N, Seldenrijk A, Beekman AT, van Hout HP, de Jonge P, Penninx BW. Cardiovascular disease in persons with depressive and anxiety disorders. J Affect Disord (2010) 125(1–3):241–8.
22. Sloan RP, Shapiro PA, Bagiella E, Boni SM, Paik M, Bigger JT Jr et al. Effect of mental stress throughout the day on cardiac autonomic control. Biol Psychol. 1994 Mar;37(2):89-99.
23. Tan DJA, Polascik BA, Kee HM, et al. The Effect of Perioperative Music Listening on Patient Satisfaction, Anxiety, and Depression: A Quasiexperimental Study. Anesthesiol Res Pract. 2020;2020:3761398.
24. McCraty R, Atkinson M, Tiller WA, Rein G, Watkins AD. The effects of emotions on short-term power spectrum analysis of heart rate variability. Am J Cardiol. 1995;76(14):1089-93.
25. Lee KC, Chao YH, Yiin JJ, Hsieh HY, Dai WJ, Chao YF. Evidence that music listening reduces preoperative patients' anxiety. Biol Res Nurs. 2012;14(1):78-84

Conflict of Interest : None