Original article

Impact of lunar cycle on heart rate variability (RR interval)

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Abstract:

Introduction: It is presumed that cardiac surgeries done during waning phase of lunar cycle and full moon night shows better survival rates. However, there are scanty scientific support for the influence of lunar cycle on cardiac function. RR interval variation, an index of cardiac autonomic imbalance, could be a simple and an ideal parameter to study cardiac neural control. Our aim was to assess variations in RR interval of Wistar rats during the period of super moon and lunar eclipse.

Materials and methods: Wistar rats weighing between 150 – 200 gms were randomly selected for study (four rats during lunar eclipse and another set of four rats during super moon night). Rats were kept in restrainer and using student physiograph ECG was recorded before, partial (during) and total (peak) of the super moon and lunar eclipse. RR interval was calculated from the ECG recordings for the analysis of cardiac sympatho vagal balance.

Observations and results: No significant difference in RR interval was observed during super moon night. However, decrease in RR interval was observed during the night of total lunar eclipse when compared to, before as well as partial eclipse period.

Conclusion: This study shows that, though super moon did not influence cardiovascular function, lunar eclipse decreases RR interval, which might be due to the existence of biological rhythm interaction with lunar electromagnetic radiations.

Key words: RR interval, lunar eclipse and super moon

Introduction:

Heart rate fluctuates with every heart beat. Variations of heart rate between beat to beat are known as heart rate variability (HRV). Indices of heart rate variability provide a window onto autonomic modulation of the heart (1). In population studies, decrease in heart rate variability has a predictive value for mortality among healthy adults (2). It is a well-established risk factor for arrhythmic events and mortality among post-myocardial patients (3). Reduced heart rate variability identifies diabetic patients with autonomic neuropathy (4). Depressed HRV is also seen in liver cirrhosis (5), sepsis (6) and tetraplegia (7). Heart rate variability in combination with other risk stratifiers like ejection fraction can identify cardiac patients with high risk of mortality (1). In the intact heart, parasympathetic fibers are inhibitory and sympathetic are excitatory. Cardiac parasympathetic inhibitory actions are reported to provide electrical stability to the heart and thus preventing from ventricular tachycardia (8). In addition, HRV is influenced by various physiological factors like stress (9), pregnancy (10), phases of menstrual cycle (11) and various environmental factors like extreme heat (12) and cold (13).

Lunar radiations influence human physiology to greater extent. Available literature shows the existence of positive correlation between different phases (waxing and waning) of lunar cycle and psychological disorder (14), surgery outcome (15), inpatient admission at hospital (16), epilepsy (17), sleep (18) and birth outcome (19). Animal studies

also exhibits variations in plasma melatonin, coricosterone level (20) and behavioural changes (21) in relation to lunar phases. In contrast, few reports indicate that, lunar cycle doesn't have any significant effect on human physiology (22, 23). In spite of different school of thoughts, it is presumed that cardiac surgeries done during waning phase of lunar cycle and full moon show better survival rates (24). However, there is no clear scientific evidence for the influence of lunar cycle on cardiac function.

Two approaches are commonly used in the measurement of heart rate variability and they are 1) analysis in the time (Longest R-R interval, shortest R-R interval and ratio of longest R-R interval to shortest R-R interval) and 2) frequency (high frequency, low frequency spectral components) domain method. The aim of the current study is to investigate RR interval variation during the two lunar events (eclipse and supermoon) in Wistar albino rats.

Materials and methods:

Lunar events:

The current study was carried out during two lunar events. 1) Super moon (biggest super moon of the decade, dated 19/03/2011) and 2) Lunar eclipse (longest lunar eclipse of the century, dated 15/06/2011) on Wistar albino rats. A "Supermoon" is the coincidence of a full moon (or a new moon) with the closest approach to the earth on its elliptical orbit. A lunar eclipse is the revolutionary movement of the moon directly behind the earth into its umbra.

After getting an approval from the institutional ethical committee, the study was initiated. Male Wistar rats weighing between 150 – 200 gms were selected for the current study (n=4 in each group - Four rats during lunar eclipse and another set of four during super moon night). Male rats were chosen in order to avoid influence of oestrus cycle on the HRV. Rats were kept in restrainer and using student physiograph ECG was recorded before the initiation of lunar events, during partial and peak (total) of the super moon and lunar eclipse (Table 1). RR interval was calculated from the mean of the ECG recording of 20 RR peaks at each time point for the analysis of cardiac sympatho vagal balance.

Table 1 - Absolute time of recordings during the Lunar event

	Before	During partial	Peak
Super Moon	7.30 pm	11.30 pm	3.30 am
Lunar Eclipse	7.15 pm	12.15 am	2.00 am

All statistical analysis was performed using an SPSS statistical package (Version 17). One-way ANOVA and Tukey's multiple comparison tests were used to compare the groups. $p < 0.05$ was considered to be statistically significant.

Result:

Decrease in RR interval (p value < 0.05) was observed during the total lunar eclipse night when compared to before as well as partial eclipse (before: 0.225±0.030, partial: 0.223±0.025 and total: 0.140±0.021 seconds) [Bar chart 1]. However, no significant difference in RR interval (p value > 0.05) was observed during super moon night (before: 0.182±0.026, partial: 0.183±0.029 and total: 0.209±0.010 seconds) [Bar chart 2].

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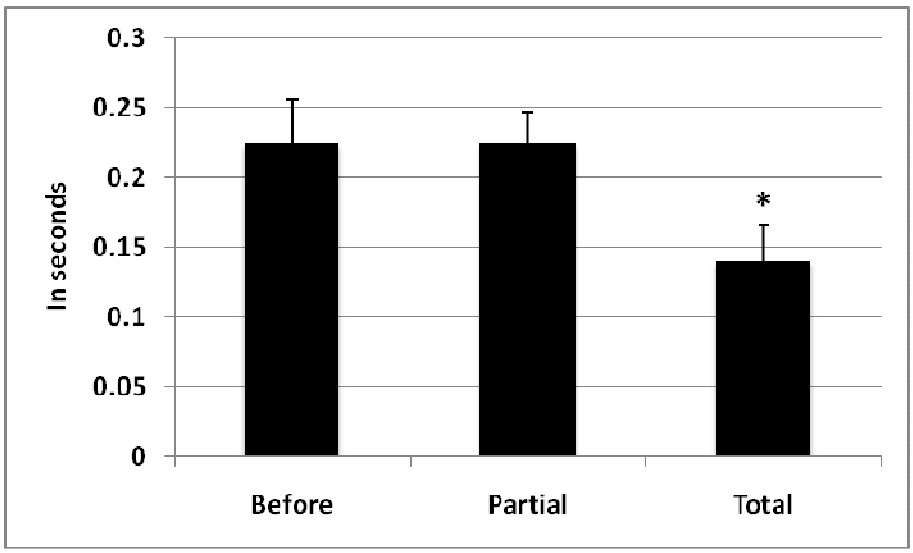
Bar chart 1 - RR interval during lunar eclipse:



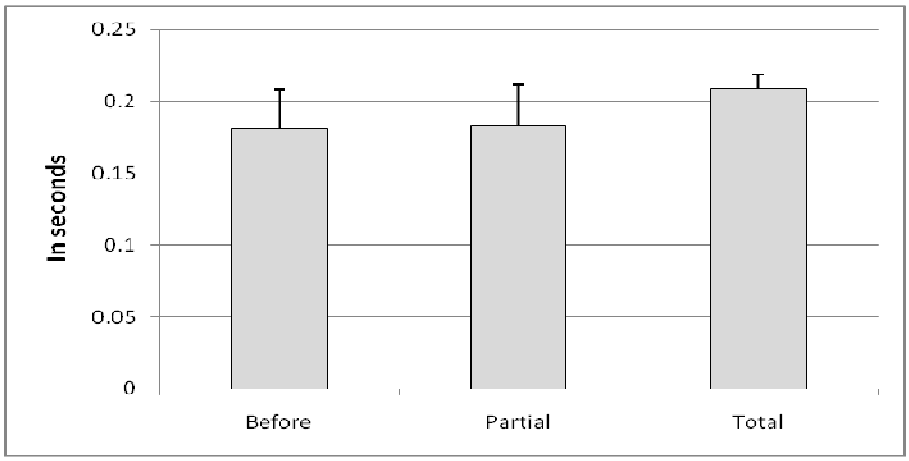
RR interval duration in seconds (before, partial and total lunar eclipse)

Values expressed in Mean ± SD

One way ANOVA with tukey's multiple comparison was done

p value < 0.05 considered to be significant

Bar chart 2 - RR interval during super moon:



RR interval duration in seconds (before, partial and total supermoon)

Values expressed in Mean ± SD

One way ANOVA with tukey's multiple comparison was done

p value < 0.05 considered to be significant

Discussion:

Various phases of the lunar cycle (29.5-day revolution cycle) exhibit a significant gravitational effect on earth. Magnitude of the gravitational force excreted by the moon depends on its mass and its proximity to earth. A classical example for the lunar cycle induced gravitational pull is rise and fall of the ocean tides. These show that lunar phases affect earth gravitational forces. But, it is unclear whether lunar events influence human electro behaviour and physiological activity. In the current study, though no significant difference in RR interval was observed during super moon night and decrease in RR interval was observed during the total lunar eclipse night when compared partial eclipse. The probable reason for this could be due to existence of biological rhythm interaction with lunar electromagnetic radiations (25).

Reports also show increase in crime, decrease in road traffic accidents on full moon days (26) and higher incidence of suicide on new moon days (27). The probable reason could be due to the lunar event induced gravitational force on body fluids, which leads to the disturbances in biological process during full moon night (28). The other possible causes for the changes in human physiology could be due to release of neurohormones which may be triggered by the electromagnetic radiation and/or the gravitational pull of the moon or via interaction of melatonin and steroid regulatory mechanism(21). Available literature supports that lunar cycle influences biological process of almost all the species, including human. A study on honey bee showed that increase in the levels of fat, steroid and body weight in hemolymph in new moon days (29). Another study documented that reproductive functions like sex hormone secretions and its control by hypothalamo hypophyseal system, sperm motility, pH and osmolarity of the fish are in synchronous with various phases of the lunar cycle (30). In addition, few types of fishes exhibit higher melatonin concentration on new moon night when compared to the full moon nights (31). Reptiles too exhibited variations in melatonin and coricosterone secretion in relation to different phases of moon (20). Few studies have also reported of difference in neural synaptic ribbion in pineal gland, increase in immune response and altered taste sensitivity in lower mammals during full moon nights (32, 33).

In a human study, the day of ovulation and menstruation were well correlated with the dark phase and new moon events respectively (34). In another research publication, it was found that number of child birth was higher in the new moon night (35). Decrease in cardiac related mortality rate was observed nearer to the new-moon and full-moon phases when compared to other nights (36). However, it was observed that incidence of acute coronary events and admission of cardiac patients were higher in the new moon nights (37). A prospective study showed that occurrence of gastrointestinal disorders like variceal haemorrhage was higher in full moon night (38). However, a report also showed that admission of patients with bacterial dysentery was less in the full moon phase when compared to other lunar phase (39). A retrospective study showed that higher urinary retention (40), increase in maxillofacial emergencies (41) in new moon period when compared to other lunar phases. In contrast, few literature documented that there were no significant relationship between the influence of the lunar cycle and patients admission (16, 42), heart attack and respiratory disorders (43) and surgical quality (44). However, additional studies have to be done in order to find the exact mechanism for the role on lunar cycle on human/animal health.

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Conclusion:

Exposure of lunar rays during moon apogee perigee events is considered to be toxic to human health. This study shows the super moon rays did not show any significant changes in cardiovascular function however; lunar eclipse causes alteration in cardiac functions. Future studies are needed to elucidate the mechanism involved.

References

1. Stein PK, Kleiger RE. Insights from the study of heart rate variability. Annual review of medicine. 1999;50:249-61. Epub 1999/03/12.

2. Liao D, Cai J, Rosamond WD, Barnes RW, Hutchinson RG, Whitsel EA, et al. Cardiac autonomic function and incident coronary heart disease: a population-based case-cohort study. The ARIC Study. Atherosclerosis Risk in Communities Study. American journal of epidemiology. 1997;145(8):696-706. Epub 1997/04/15.

3. Carpeggiani C, L'Abbate A, Landi P, Michelassi C, Raciti M, Macerata A, et al. Early assessment of heart rate variability is predictive of in-hospital death and major complications after acute myocardial infarction. International journal of cardiology. 2004;96(3):361-8. Epub 2004/08/11.

4. Pencic-Popovic B, Celic V, Cosic Z, Pavlovic-Kleut M, Caparevic Z, Kostic N, et al. Heart rate variability and increased risk for developing type 2 diabetes mellitus. Vojnosanitetski pregled. 2014;71(12):1109-15. Epub 2015/02/03.

5. Mani AR, Montagnese S, Jackson CD, Jenkins CW, Head IM, Stephens RC, et al. Decreased heart rate variability in patients with cirrhosis relates to the presence and degree of hepatic encephalopathy. American journal of physiology Gastrointestinal and liver physiology. 2009;296(2):G330-8. Epub 2008/11/22.

6. Griffin MP, Moorman JR. Toward the early diagnosis of neonatal sepsis and sepsis-like illness using novel heart rate analysis. Pediatrics. 2001;107(1):97-104. Epub 2001/01/03.

7. Gholami M, Mazaheri P, Mohamadi A, Dehpour T, Safari F, Hajizadeh S, et al. Endotoxemia is associated with partial uncoupling of cardiac pacemaker from cholinergic neural control in rats. Shock (Augusta, Ga). 2012;37(2):219-27. Epub 2012/01/18.

8. Palma JA, Benarroch EE. Neural control of the heart: recent concepts and clinical correlations. Neurology. 2014;83(3):261-71. Epub 2014/06/15.

9. Kang D, Kim Y, Kim J, Hwang Y, Cho B, Hong T, et al. Effects of high occupational physical activity, aging, and exercise on heart rate variability among male workers. Annals of occupational and environmental medicine. 2015;27:22. Epub 2015/09/29.

10. Reyes-Lagos JJ, Echeverria-Arjonilla JC, Pena-Castillo MA, Garcia-Gonzalez MT, Ortiz-Pedroza Mdel R, Pacheco-Lopez G, et al. A comparison of heart rate variability in women at the third trimester of pregnancy and during low-risk labour. Physiology & behavior. 2015;149:255-61. Epub 2015/06/07.

11. Tenan MS, Brothers RM, Tweedell AJ, Hackney AC, Griffin L. Changes in resting heart rate variability across the menstrual cycle. Psychophysiology. 2014;51(10):996-1004. Epub 2014/06/20.

12. Natali JE, Santos BT, Rodrigues VH, Chaui-Berlinck JG. Analysis of heart rate control to assess thermal sensitivity responses in Brazilian toads. Brazilian journal of medical and biological research = Revista brasileira de pesquisas medicas e biologicas / Sociedade Brasileira de Biofisica [et al]. 2014;0:0. Epub 2014/10/30.

13. Flouris AD, Poirier MP, Bravi A, Wright-Beatty HE, Herry C, Seely AJ, et al. Changes in heart rate variability during the induction and decay of heat acclimation. European journal of applied physiology. 2014;114(10):2119-28. Epub 2014/06/25.

14. Byrnes G, Kelly IW. Crisis calls and lunar cycles: a twenty-year review. Psychological reports. 1992;71(3 Pt 1):779-85. Epub 1992/12/01.

15. Smolle J, Prause G, Kerl H. A double-blind, controlled clinical trial of homeopathy and an analysis of lunar phases and postoperative outcome. Archives of dermatology. 1998;134(11):1368-70. Epub 1998/11/26.

16. Zargar M, Khaji A, Kaviani A, Karbakhsh M, Yunesian M, Abdollahi M. The full moon and admission to emergency rooms. Indian journal of medical sciences. 2004;58(5):191-5. Epub 2004/05/29.

17. Baxendale S, Fisher J. Moonstruck? The effect of the lunar cycle on seizures. Epilepsy & behavior : E&B. 2008;13(3):549-50. Epub 2008/07/08.

18. Della Monica C, Atzori G, Dijk DJ. Effects of lunar phase on sleep in men and women in Surrey. Journal of sleep research. 2015. Epub 2015/06/23.

19. Staboulidou I, Soergel P, Vaske B, Hillemanns P. The influence of lunar cycle on frequency of birth, birth complications, neonatal outcome and the gender: a retrospective analysis. Acta obstetricia et gynecologica Scandinavica. 2008;87(8):875-9. Epub 2008/07/09.

20. Tarlow EM, Hau M, Anderson DJ, Wikelski M. Diel changes in plasma melatonin and corticosterone concentrations in tropical Nazca boobies (Sula granti) in relation to moon phase and age. General and comparative endocrinology. 2003;133(3):297-304. Epub 2003/09/06.

21. Zimecki M. The lunar cycle: effects on human and animal behavior and physiology. Postepy higieny i medycyny doswiadczalnej (Online). 2006;60:1-7. Epub 2006/01/13.

22. Sjodin A, Hjorth MF, Damsgaard CT, Ritz C, Astrup A, Michaelsen KF. Physical activity, sleep duration and metabolic health in children fluctuate with the lunar cycle: science behind the myth. Clinical obesity. 2015;5(2):60-6. Epub 2015/03/27.

23. Kuehnl A, Herzog M, Schmidt M, Hornung HM, Jauch KW, Hatz RA, et al. The dark side of the moon: impact of moon phases on long-term survival, mortality and morbidity of surgery for lung cancer. European journal of medical research. 2009;14(4):178-81. Epub 2009/04/22.

24. Shuhaiber JH, Fava JL, Shin T, Dobrilovic N, Ehsan A, Bert A, et al. The influence of seasons and lunar cycle on hospital outcomes following ascending aortic dissection repair. Interactive cardiovascular and thoracic surgery. 2013;17(5):818-22. Epub 2013/07/11.

25. Neumann D. [Tidal and lunar rhythms (author's transl)]. Arzneimittel-Forschung. 1978;28(10a):1842-9. Epub 1978/01/01. Tide- und Lunarrhythmen.

26. Alonso Y. Geophysical variables and behavior: LXXII. Barometric pressure, lunar cycle, and traffic accidents. Perceptual and motor skills. 1993;77(2):371-6. Epub 1993/10/01.

27. Oderda GM, Klein-Schwartz W. Lunar cycle and poison center calls. Journal of toxicology Clinical toxicology. 1983;20(5):487-95. Epub 1983/07/01.

28. Biermann T, Estel D, Sperling W, Bleich S, Kornhuber J, Reulbach U. Influence of lunar phases on suicide: the end of a myth? A population-based study. Chronobiology international. 2005;22(6):1137-43. Epub 2006/01/06.

29. Mikulecky M, Bounias M. Worker honeybee hemolymph lipid composition and synodic lunar cycle periodicities. Brazilian journal of medical and biological research = Revista brasileira de pesquisas medicas e biologicas / Sociedade Brasileira de Biofisica [et al]. 1997;30(2):275-9. Epub 1997/02/01.

30. Rahman MS, Morita M, Takemura A, Takano K. Hormonal changes in relation to lunar periodicity in the testis of the forktail rabbitfish, Siganus argenteus. General and comparative endocrinology. 2003;131(3):302-9. Epub 2003/04/26.

31. Rahman MS, Kim BH, Takemura A, Park CB, Lee YD. Effects of moonlight exposure on plasma melatonin rhythms in the seagrass rabbitfish, Siganus canaliculatus. Journal of biological rhythms. 2004;19(4):325-34. Epub 2004/07/13.

32. Martinez-Soriano F, Ruiz-Torner A, Armananzas E, Valverde-Navarro AA. Influence of light/dark, seasonal and lunar cycles on serum melatonin levels and synaptic bodies number of the pineal gland of the rat. Histology and histopathology. 2002;17(1):213-22. Epub 2002/01/30.

33. Pavlova MB. [A comparative study of the taste sensitivity to phenylthiocarbamide in rats differing by the threshold of nervous system excitability]. Zhurnal vysshei nervnoi deiatelnosti imeni I P Pavlova. 1997;47(1):123-9. Epub 1997/01/01. Sravnitel'noe izuchenie vkusovoi chuvstvitel'nosti k feniltiokarbamidu u krys, razlichaiushchikhsia po progu vozbudimosti nervnoi sistemy.

34. Law SP. The regulation of menstrual cycle and its relationship to the moon. Acta obstetricia et gynecologica Scandinavica. 1986;65(1):45-8. Epub 1986/01/01.

35. Ghiandoni G, Secli R, Rocchi MB, Ugolini G. [Incidence of lunar position in the distribution of deliveries. A statistical analysis]. Minerva ginecologica. 1997;49(3):91-4. Epub 1997/03/01. Incidenza della posizione lunare sulla distribuzione dei parti. Una analisi statistica.

36. Sitar J. [The causality of lunar changes on cardiovascular mortality]. Casopis lekaru ceskych. 1990;129(45):1425-30. Epub 1990/11/09. K pricinam lunarnich zmen kardiovaskularni umrtnosti.

37. Oomman A, Ramachandran P, Shanmugapriya, Subramanian P, Nagaraj BM. A novel trigger for acute coronary syndromes: the effect of lunar cycles on the incidence and in-hospital prognosis of acute coronary syndromes--a 3-year retrospective study. Journal of the Indian Medical Association. 2003;101(4):227-8. Epub 2003/09/11.

38. Roman EM, Soriano G, Fuentes M, Galvez ML, Fernandez C. The influence of the full moon on the number of admissions related to gastrointestinal bleeding. International journal of nursing practice. 2004;10(6):292-6. Epub 2004/11/17.

39. Mikulecky M, Schreter I. [Occurrence of acute infectious diarrhea during the lunar phases]. Casopis lekaru ceskych. 1993;132(16):498-501. Epub 1993/08/23. Vyskyt akutnych infekcnych hnaciek v priebehu mesacneho cyklu.

40. Payne SR, Deardon DJ, Abercrombie GF, Carlson GL. Urinary retention and the lunisolar cycle: is it a lunatic phenomenon? BMJ (Clinical research ed). 1989;299(6715):1560-2. Epub 1989/12/23.

41. Butler S, Songra A, Hardee P, Hutchison I. The moon and its relationship to oral and maxillofacial emergencies. The British journal of oral & maxillofacial surgery. 2003;41(3):170-2. Epub 2003/06/14.

42. Wolbank S, Prause G, Smolle-Juettner F, Smolle J, Heidinger D, Quehenberger F, et al. The influence of lunar phenomena on the incidence of emergency cases. Resuscitation. 2003;58(1):97-102. Epub 2003/07/18.

43. Alves DW, Allegra JR, Cochrane DG, Cable G. Effect of lunar cycle on temporal variation in cardiopulmonary arrest in seven emergency departments during 11 years. European journal of emergency medicine : official journal of the European Society for Emergency Medicine. 2003;10(3):225-8. Epub 2003/09/16.

44. Holzheimer RG, Nitz C, Gresser U. Lunar phase does not influence surgical quality. European journal of medical research. 2003;8(9):414-8. Epub 2003/10/14.