Short Communication

Heart Rate Variability Changes During and after the Practice of Bhramari Pranayama

Abstract

Background: Yoga is an ancient Indian science as well as the way of life. Pranayama is one of the most important yogic practices. Bhramari pranayama was shown to produce a reduction in blood pressure after the practice and thus reported to produce parasympathetic activity. However, there are no known studies reported the heart rate variability (HRV) changes either during or after the practice of Bhramari. Hence, this study aims at evaluating the HRV changes during and after the practice. **Materials and Methods:** Sixteen (9 males, 7 females) healthy volunteers with the mean ± standard deviation age of 23.50 ± 3.01 years were recruited. All the subjects performed Bhramari pranayama for the duration of 5 min. Assessments were taken before, during, and immediately after the practice of pranayama. Statistical analysis was performed using students paired samples *t*-test, Wilcoxon signed-ranks test and repeated measures of analysis of variance and *Post-hoc* analysis with Bonferroni adjustment for multiple comparisons. **Results:** Results of this study showed a significant increase in HR and low frequency spectrum of HRV and a significant reduction in high frequency spectrum of HRV during the practice of Bhramari which revert to normal after the practice. **Conclusion:** Results of this study suggests that there might be a parasympathetic withdrawal during the practice of Bhramari. However, further studies are required to warrant the findings of this study.

Keywords: *Bhramari pranayama, blood pressure, heart rate variability*

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Introduction

Yoga is an ancient Indian science as well as the way of life, which includes the practice of specific posture (asana) and regulated breathing (pranayama). Pranayama is one of the most important yogic practices.[1] Different types of pranayama were reported to produce different cardiovascular[2] and autonomic responses[3] in healthy individuals.[2,3]

Bhramari pranayama (humming bee breath) is one of the common pranayama practice, which involves inhaling through both nostrils and while exhaling produce sound of humming bee.[1]

A previous study stated that "the practice of Bhramari pranayama influences the parasympathetic dominance on cardiovascular system due to its effect in reducing systolic blood pressure (SBP), diastolic BP (DBP), and mean arterial pressure (MAP)."[4]

There are several methods available to measure cardiac autonomic nervous system, of which heart rate variability (HRV) has been established as a noninvasive tool. Classical spectral analysis of HRV signals distinguishes sympathetic from the parasympathetic activity.[5]

Many studies have reported the HRV of pranayama practices before and after the practice but only very few studies have reported the HRV during the pranayama practices such as alternate nostril breathing[6] and Kapalbhati.[7] Since, Bhramari pranayama was reported to produce parasympathetic activity without assessing autonomic measures, we had a research question as "Does Bhramari pranayama produce parasympathetic activity?." Based on the previous study observations and reports,[4,8] we hypothesized that Bhramari pranayama may produce parasympathetic activity and hence, this present study aims at evaluating HRV (a noninvasive tool used to find sympathetic and parasympathetic activity)[5] changes during and after the practice of Bhramari pranayama.

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Materials and Methods

Subjects

Sixteen (9 males, 7 females) healthy volunteers with the mean ± standard deviation age of 23.50 ± 3.01 years were recruited from a residential yoga university, South India. Subjects aged 18 years and above experienced in practicing yoga for more than 1 year and willingness to participate in the study were included. Subjects with the history of any systemic and mental illness, regular use of medication for any diseases, chronic smoking, and alcoholism were excluded from this study. The study protocol was approved by the Institutional Ethics Committee and a written informed consent was obtained from each subject.

Of 40 subjects assessed for eligibility, 22 subjects did not fulfill the inclusion criteria and hence, did not include in the study. Recruited 18 subjects underwent Bhramari pranayama practice. Demographic variables of the study subjects were shown in Table 1.

The design of the study

This is a single group repeated measures study, in which all the subjects were asked to perform Bhramari pranayama for the duration of 5 min. Assessments were performed before, during, and after the intervention.

Assessment

HR and HRV: HR and HRV were assessed before, during, and after the intervention using a four-channel polygraph (Polyrite D, Recorders and Medicare Systems, Chandigarh, India). The Ag/AgCl pregelled electrodes were placed according to the standard limb lead II configuration for recording electrocardiogram (ECG). Data were acquired at the sampling rate of 1024 Hz.[9]

BP: SBP and DBP were assessed before and after the intervention using sphygmomanometer.

Data extraction

Frequency domain and time domain analysis of the HRV data were carried out at baseline, during and post-intervention (5 min recordings for each). The data recorded were visually inspected off-line, and only noise-free data were included for the analysis. The data were analyzed with an HRV analysis software (Kubios HRV version 2.0, Biomedical Signal Analysis Group, Department of physics, University of Kuopio, Finland).[10]

The energy in the HRV series in the following specific frequency bands was studied: Low frequency (LF) band (0.04–0.15 Hz), and high-frequency (HF) band (0.15–0.4 Hz). LF/HF ratio was also calculated.[11]

The LF and HF band values were expressed as normalized units. The following components of the time domain HRV were analyzed: (1) the mean of the intervals between adjacent QRS complexes or the instantaneous HR (RR Intervals), (2) standard deviation of RR Intervals (SDNN) (3) HR, (4) the square root of the mean of the sum of the squares of differences between adjacent normal-to-normal (NN) intervals (RMSSD), (5) the number of interval differences of successive NN intervals >50 ms (NN50), and (6) the proportion derived by dividing NN50 by the total number of NN intervals (pNN50).[8] Assessments such as pulse pressure (PP), MAP were derived using following formulas. PP was calculated as (SBP − DBP); MAP as (DBP + ⅓ PP).[12]

Table 1: Demographic variables of the study group (*n*=16)

Variables	Study group (*n* = 16)
Age (years)	23.50±3.01
Gender	Female (*n*=7), male (*n*=9)
Height (cm)	165.44±12.86
Weight (kg)	60.56±8.91
BMI (kg/m^2)	22.16±2.35

BMI = Body mass index

Intervention

All the subjects were asked to perform Bhramari pranayama by inhaling through both nostrils and while exhaling produced the sound of humming bee for the duration of 5 min at the rate of 6 breath/min.[1]

Data analysis

Of 18 subjects, 2 female subjects RRInterval could not be extracted from the ECG due to "T" wave elevation and hence, these data were not included in the statistical analysis. Rests of the data were checked for the normality using Shapiro–Wilk test. Statistical analysis for BP was performed using Student's paired samples *t*-test (data that were normally distributed) and Wilcoxon signed-ranks test (data that were not normally distributed) and HRV data were analyzed using repeated measures of analysis of variance and *Post-hoc* analysis with Bonferroni adjustment for multiple comparisons with the use of Statistical Package for the Social Sciences (SPSS) for Windows, Version 16.0. Chicago, SPSS Inc. $P < 0.05$ was considered statistically significant.

Results

Results of this present showed a significant increase in HR and LF spectrum of HRV and a significant reduction in HF spectrum of HRV during the practice of Bhramari, and it reverts back to normal during the recovery period after the practice. It also showed a significant reduction in SBP, DBP, and MAP after the practice and such significant changes were observed in rest of the variables [Table 2].

Discussion

HR is influenced by physical, emotional, and cognitive activities. Physiological oscillations that lead to variable

Table 2: Baseline, during, and postassessments of study group (*n*=16)

Variables	Study group (*n*=16)		
	Baseline	During	Post
SBP (mmHg)†	115.50±7.75	-	110.50±8.56*
DBP (mmHg)†	76.88±6.28	-	72.38±5.94*
PP (mmHg)#	38.63±4.36	-	38.13±4.59
MAP (mmHg)†	89.75±6.49	-	85.08±6.58*
RR Intervals (ms)¶	736.27±81.44	727.23±82.10	745.20±64.73
SDNN (ms)¶	52.92±16.69	50.39±17.37	58.58±16.01
HR (b/min)¶	83.18±7.98	87.35±6.40*	81.80±6.63
RMSSD (ms)¶	39.33±16.92	37.38±19.04	40.57±13.08
NN50 (count)¶	61.75±47.26	51.56±28.65	57.69±52.83
pNN50 (%)¶	15.69±12.59	12.64±7.27	14.49±13.16
LF (n.u)¶	60.75±23.63	81.75±13.04*	71.12±22.84
HF (n.u)¶	39.20±23.55	18.19±13.00*	28.74±22.62
LF/HF (ms²)¶	3.05±3.07	9.33±8.52	5.18±4.83

All values are in mean±SD. †Student paired samples-*t*-test, #Wilcoxon signed ranks test, ¶Repeated measures of analysis of variance, *$P<0.05$. SBP = Systolic blood pressure, DBP = Diastolic blood pressure, PP = Pulse pressure, MAP = Mean arterial pressure, RR Intervals = The intervals between adjacent QRS complexes or the instantaneous HR, SDNN = Standard deviation of RR Intervals, HR = Heart rate, RMSSD = The square root of the mean of the sum of the squares of differences between adjacent NN intervals, NN50 = The number of interval differences of successive NN intervals greater than 50 ms, pNN50 = Proportion derived by dividing NN50 by the total number of NN intervals, LF = Low frequency, HF = High frequency, LFHF ratio = Ratio of low frequency to high frequency, SD = Standard deviation

beat-to-beat fluctuations in HR are known as HRV. Hence, HR and HRV are the most sensitive and easily accessible indicators of sympathetic and parasympathetic activity and autonomic regulation. The time domain analysis of HRV mainly reflects parasympathetic outflow and frequency domain analysis reflects overall autonomic balance and is the most widely used tool to investigate HRV and involves decomposition of sequential RRIntervals into sinusoidal components of different amplitude and frequency. Just as HF band power is related to parasympathetic activity, LF band power is often related to sympathetic activity, yet the interpretation and clinical significance of HRV in the LF band have aroused intense controversy. The relationship between the LF band and sympathetic activity has been disputed because LF band power has been shown to be partly under parasympathetic control.[11] HF band power is mainly under parasympathetic control.[5]

Results of this present showed a significant increase in HR and LF spectrum of HRV and a significant reduction in HF spectrum of HRV during the practice of Bhramari compared to its baseline, and it reverts back to normal during the recovery period after the practice. This effect might be possibly through its slow breathing techniques because slow yoga breathing practices were reported to increase HR fluctuations in the LF band with simultaneous increases in HR; or breathing at 4.5 and 6.5/min frequency or other rhythmical stimulation at this frequency such as rhythmical skeletal muscle contraction were reported to reflect in large increases in the LF band and simultaneous decreases in the HF band. Such resonance effects were also reported with yoga slow breathing practices, mantra chanting, and some meditative practices.[11]

A comprehensive review reported as the large amplitude HR oscillations occurring in the LF range resulting from breathing at an optimal frequency may reflect resonance, also known as "coherence" occurring due to entrainment between HR, BP, and the relaxation response rather than sympathetic tone.[11] And since, the time domain variables of HRV and the HF band power of frequency domain are mainly the indicative of the parasympathetic activities, the insignificant reduction in these variables such as RRI, SDNN, RMSSD, NN50, pNN50 (time domain), and significant reduction in HF band power (Frequency domain) along with significant increase in HR during the practice of Bhramari pranayama, we believe that there might be a parasympathetic withdrawal while practicing Bhramari pranayama.

Due to the reduction in the BP level after the practice of Bhramari pranayama, previous studies has stated that "Bhramari pranayama induces parasympathetic dominance on cardiovascular system"[4,8] whereas, findings of this present study is contradicting the statement of the previous studies. At the same time, the previous study's findings such as significant reduction in SBP, DBP, MAP,[4,8] and mild fall in HR after the Bhramari pranayama were similar to this present study findings.[4] Hence, reduction in the BP might not attribute to the increased level of parasympathetic activity, but it might attribute to other mechanisms which are unclear and need to be evaluated in the future studies.

Strengths of the study

The first study evaluating the HRV during the practice of Bhramari pranayama. Standard equipment was used for assessments. Although the BP was assessed using sphygmomanometer, the assessment was performed by the intern who was not in the part of the study.

Limitations of the study

The study was conducted in the healthy volunteers, hence limiting the application of its findings to pathological conditions. Additional assessments, such as continuous BP monitoring, baroreceptor sensitivity, photoplethysmography, and galvanic skin resistance would have given a better understanding of the state of the autonomic nervous system. The present study assessed only the HRV and BP changes in one group and did not have the control group and also did not assess its underlying mechanisms. Hence, further studies are required (i.e., randomized controlled trials) engaging a larger sample size, using advanced techniques, and taking place over a greater period, to evaluate its precise physiological effects and underlying mechanisms.

Conclusion

Results of this study suggest that there might be a parasympathetic withdrawal during the practice of Bhramari that revert back to normal after the practice. However, further studies are required to warrant the findings of this study.

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Conflicts of interest

There are no conflicts of interest.

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