Immediate Effects of Yoga Based Relaxation Technique Yoga Nidra on Heart Rate Variability in Young and Healthy Volunteers

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ABSTRACT

Background: Cardiovascular autonomic functions are affected by the negative influences of stress which bring about alterations in heart rate variability (HRV). Yoga based relaxation techniques like Yoga Nidra have been found to relieve stress as shown by improved HRV. This study was conducted to assess the immediate effects of a yoga based guided relaxation technique, Yoga Nidra on HRV parameters in young and healthy volunteers.

Methods: This was an interventional study conducted in the Department of Clinical Physiology, Institute of Medicine, Maharajgunj. Fifty two male medical students were divided into supine rest group (n=26) and Yoga Nidra group (n=26). HRV indices were recorded before and after supine rest and Yoga Nidra. Intra-group and inter-group comparisons of the HRV parameters were done before and after the interventions.

Results: In comparison to the supine rest, Yoga Nidra produced significant increase in values of HF (1460.72 Vs 3272.99; p=0.03) and HFnu (50.32 Vs 62.68; p=0.004); and significant reduction in the values of LFnu (49.68 Vs 37.32; p=0.004) and LF:HF ratio (0.99 Vs 0.59; p=0.004), which suggested that the parasympathetic modulating response of Yoga Nidra was better than that of supine rest.

Conclusion: Yoga Nidra, a yoga based relaxation technique brings better relaxation response than supine rest as indicated by the significantly improved HRV indices.

Keywords: frequency domain indices; heart rate variability; time domain indices; yoga; yoga nidra

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INTRODUCTION

Heart rate is influenced by various physical, emotional and cognitive activities.[1] Heart rate variability (HRV) refers to the beat to beat variation of spontaneous heart rate in an electrocardiogram (ECG).[2]

Modern competitive achievement based lifestyle along with changing environmental and socio-political scenario has led to increased risks of psychosocial disturbances leading to stress and stress related illnesses.[3] Physiological and psychological stressors have been found to bring about a disruption in autonomic balance, and a prolonged autonomic imbalance is associated with a wide range of psychosomatic disorders.[4] Neurobiological evidences suggest that HRV is affected by stress. Artificially induced stress have been found to alter HRV variables. Hence, HRV can be used for assessing psychological health and stress of individuals.[5] With the advent of digital signal processing systems, it has been possible to quantify the balance in autonomic nervous system (ANS) by the measures of HRV.[6]

Practice of yoga, particularly meditation and relaxation techniques, has been known to ensure a balance in ANS, also referred to as "sympatho-vagal-balance", as indicated by an improved HRV.[7] It has been found that yogic relaxation techniques bring about "relaxation response" which is the physiological opposite of stress or fight-or-flight response. This leads to a reduction in sympathetic nervous activity and stimulation of parasympathetic activity reflected by recovery from fatigue, reduced stress and improvement in visceral and metabolic functions.[8] One of such yogic relaxation techniques is Yoga Nidra, which is a systematic technique of guided relaxation requiring conscious rotation of awareness around different parts of the body.[9] Yoga Nidra technique has been found produce favorable changes in HRV by shifting autonomic balance to its parasympathetic branch.[10] The number of reports on the effects of this technique on HRV is scanty. Hence, this study was conducted to analyze the immediate effects of Yoga Nidra relaxation on HRV of young and healthy volunteers and compare it with the effects of simple supine rest maneuver.

MATERIALS AND METHODS

It was an interventional controlled before-after study. The study was conducted in the Department of Clinical Physiology, Maharajgunj Medical Campus, Institute of Medicine (IOM) from June 2016 to December 2016. Ethical clearance was obtained from the Institution Review Board (IRB) of IOM, Maharajgunj for the study.

A total of 52 young and apparently healthy male students from first and second year were recruited for the study by convenient sampling technique and were allocated into two groups with 26 participants in each: supine rest group undergoing non-yogic supine rest and Yoga Nidra group undergoing guided Yoga Nidra relaxation technique. Students with major psychiatric, neurological or systemic diseases; those under treatment with drugs influencing cardiac autonomic regulation; smokers; and regular practitioners of yoga were excluded from the study.

All HRV study sessions were performed inside a well-ventilated, private, quiet and comfortable room of the Physiology Practical Laboratory of Maharajgunj Medical Campus. The participants were instructed not to consume tea, coffee for at least 12 hours and alcohol for at least 24 hours prior to testing. The subjects were also instructed to avoid strenuous physical activity for 24 hours before the test. The HRV studies were carried out in the early morning hours between 6 am to 9 am at ambient room temperature.

The supine rest group was instructed to lie down supine with eyes closed and to breathe normally for 20 minutes. The Yoga Nidra group underwent 20-minute guided Yoga Nidra relaxation. They were asked to lie in *Shavasana* (the corpse pose of Yoga), close their eyes, and breathe normally while taking gentle attention to different parts of the body as guided by the audio track.

HRV data were recorded and measured with a Polar V800 heart rate monitor and Polar H7 heart rate sensor (Polar Electro Oy, Kempele, Finland). HRV data were recorded throughout the duration of the intervention and the indices during the last 5-minutes of the 20-minute sequence were taken to be the post-intervention data. Kubios HRV Standard software version 2.2 (Kubios Oy, Kuopio, Eastern Finland) was used to calculate the time-domain and frequency-domain measures of HRV.

The recorded time-domain measures were standard deviation of the normal to normal intervals (SDNN), root mean square of successive differences of interval (RMSSD), pair of successive normal to normal intervals that differ by more than 50 milliseconds (NN50) and proportion derived by dividing NN50 by the total number of NN intervals (pNN50). The recorded frequency-domain measures were low frequency power (LF), high frequency power (HF), total power (TP), ratio of LF-to-HF power (LF:HF), normalized low frequency (LFnu), normalized high frequency (HFnu) Data thus obtained were analyzed with IBM SPSS version 21. The HRV data were expressed as median and interquartile range (q1-q3). Normality of the data was assessed using Kolmogorov Smirnov and Shapiro Wilk tests, which indicated that the distribution of the data was not normal. Therefore, non-parametric tests of significance were used. Wilcoxon signed ranks test was applied to make within-the group comparisons of before and after data. Mann Whitney U test was applied to make between-the-groups comparisons of before and after data. The physiological baseline characteristics of two groups age, weight, body mass index (BMI), pulse and blood pressure (BP) were compared with student's t-test.

RESULTS

A total of 52 young and healthy male medical students from the first and second years of medical program at Maharajgunj Medical Campus, IOM, Maharajgunj, Kathmandu were recruited for the study. The mean age of the supine rest group and Yoga Nidra group were 20.19±0.57 years and 20.15±0.61 years respectively with no statistically significant difference (p=0.81). The mean BMI of the supine rest group (21.17±1.70 kg/m^2) was not significantly different (p=0.38) from the mean BMI of the Yoga Nidra group (21.58 ±1.70 kg/m^2). BMI of all participants of the study fell within the normal range.

Table 1. Resting blood pressure and pulse rate of the participants

Parameters	Supine rest group (n = 26)	Yoga Nidra group (n = 26)	p-value
Pulse rate (BPM)	70.23±8.896	70.19±9.01	0.99
SBP (mmHg)	114.38±7.67	114.00±5.25	0.83
DBP (mmHg)	71.00±7.05	72.08±6.66	0.57

The resting pulse rate and blood pressure of the participants are shown in Table 1. The resting pulse rates, systolic blood pressures and diastolic blood pressure of the supine rest group and Yoga Nidra group were within the normal physiological ranges and the mean values did not show statistically significant difference.

Comparison of HRV indices before and after supine rest in supine rest group is shown in Table 2. Statistical analyses by Wilcoxon signed ranks test showed that the median values of all time-domain indices SDNN, RMSSD, NN50 and pNN50 were increased after the intervention as compared to the data before the intervention, and were statistically significant ($p<0.05$). Comparative analysis of frequency-domain HRV indices before and after intervention showed that the median values of LF, HF and TP were significantly higher ($p<0.05$) after the intervention compared to the baseline. The post-intervention median value of HFnu was lower and those of LFnu and LF: HF ratio higher compared to the baseline, but the differences were not statistically significant.

Table 2. HRV indices in supine rest group before and after supine rest

HRV indices		Before supine rest		After supine rest		p-value
		Median	**Interquartile range (q1-q3)**	**Median**	**Interquartile range (q1-q3)**	
Time domain	SDNN (ms)	49.25	37.28-63.15	63.80	48.85-94.22	<0.001*
	RMSSD (ms)	56.67	39.47-73.30	72.59	46.70-97.48	<0.001*
	NN50	114.50	64.50-151.25	140.00	81.00-162.75	0.001*
	pNN50 (%)	33.52	16.21-49.75	46.21	22.96-54.87	0.001*
Frequency domain	LF power (ms^2)	836.87	425.69-1964.35	1521.21	923.02-3232.57	<0.001*
	HF power (ms^2)	903.64	706.06-1633.86	1460.72	1042.71-3515.75	<0.001*
	TP (ms^2)	1973.12	1171.96-4205.62	3373.44	2549.32-7663.37	<0.001*
	LFnu	46.70	34.44-59.20	49.68	33.63-66.03	0.21
	HFnu	53.30	40.80-65.56	50.32	33.97-66.37	0.21
	LF:HF	0.88	0.53-1.45	0.99	0.51-1.94	0.07

*statistically significant

Table 3. HRV indices in Yoga Nidra group before and after Yoga Nidra

HRV indices		**Before Yoga Nidra**		**After Yoga Nidra**		**p-value**
		Median	Interquartile range (q1-q3)	Median	Interquartile range (q1-q3)	
Time domain	SDNN (ms)	49.91	38.27-76.80	69.43	55.86-98.68	<0.001*
	RMSSD (ms)	52.92	40.72-78.03	80.10	51.73-104.03	<0.001*
	NN50	106.50	58.75-158.25	141.00	81.25-186.75	<0.001*
	pNN50 (%)	30.53	16.67-50.61	45.53	26.84-61.66	<0.001*
Frequency domain	LF power (ms^2)	877.47	589.64-1504.27	1647.35	963.07-3173.15	0.001*
	HF power (ms^2)	1187.43	458.48-3222.63	3272.99	1359.50-4934.90	<0.001*
	TP (ms^2)	2315.38	1286.30-4874.01	5254.38	2814.78-9309.68	<0.001*
	LFnu	43.13	31.26-64.48	37.32	25.64-44.15	0.02*
	HFnu	56.87	35.52-68.74	62.68	55.85-74.36	0.02*
	LF:HF	0.76	0.45-1.82	0.59	0.34-0.79	0.009*

*statistically significant

Comparison of HRV indices before and after intervention in Yoga Nidra group is shown in Table 3. Statistical analyses by Wilcoxon signed ranks test showed that the median values of all time-domain indices SDNN, RMSSD, NN50 and pNN50 were increased significantly after Yoga Nidra as compared to data before the intervention, and were statistically significant ($p<0.05$); while in frequency-domain indices, the median values of LF, HF, TP and HFnu were significantly higher ($p<0.05$) after the intervention compared to the baseline, whereas the values of LFnu and LF:HF ratio were significantly lower ($p<0.05$) after the intervention.

Comparison of baseline HRV indices (before the intervention) between supine rest group and Yoga Nidra group is shown in Table 4. Statistical analyses by Mann Whitney U tests showed that the baseline median values of both time and frequency domains before the intervention in two groups were not significantly different.

Table 4. Comparison of baseline HRV indices between supine rest and Yoga Nidra group

HRV indices		Supine rest group		Yoga Nidra group		p-value
		Median	Interquartile range (q1-q3)	Median	Interquartile range (q1-q3)	
Time domain	SDNN (ms)	49.25	37.28-63.15	49.91	38.27-76.80	0.76
	RMSSD (ms)	56.67	39.47-73.30	52.92	40.72-78.03	0.90
	NN50	114.50	64.50-151.25	106.50	58.75-158.25	0.86
	pNN50 (%)	33.52	16.21-49.75	30.53	16.67-50.61	0.67
Frequency domain	LF power (ms^2)	836.87	425.69-1964.35	877.47	589.64-1504.27	0.94
	HF power (ms^2)	903.64	706.06-1633.86	1187.43	458.48-3222.63	0.67
	TP (ms^2)	1973.12	1171.96-4205.62	2315.38	1286.30-4874.01	0.63
	LFnu	46.70	34.44-59.20	43.13	31.26-64.48	0.84
	HFnu	53.30	40.80-65.56	56.87	35.52-68.74	0.84
	LF:HF	0.88	0.53-1.45	0.76	0.45-1.82	0.84

Table 5: Comparison of post-intervention HRV indices between supine rest & Yoga Nidra group

HRV indices		Supine rest group		Yoga Nidra group		p-value
		Median	**Interquartile range (q1-q3)**	**Median**	**Interquartile range (q1-q3)**	
Time domain	**SDNN (ms)**	63.80	48.85-94.22	69.43	55.86-98.68	0.31
	RMSSD (ms)	72.59	46.70-97.48	80.10	51.73-104.03	0.42
	NN50	140.00	81.00-162.75	141.00	81.25-186.75	0.71
	pNN50 (%)	46.21	22.96-54.87	45.53	26.84-61.66	0.81
Frequency domain	**LF power (ms^2)**	1521.21	923.02-3232.57	1647.35	963.07-3173.15	0.89
	HF power (ms^2)	1460.72	1042.71-3515.75	3272.99	1359.50-4934.90	0.03*
	TP (ms^2)	3373.44	2549.32-7663.37	5254.38	2814.78-9309.68	0.18
	LFnu	49.68	33.63-66.03	37.32	25.64-44.15	0.004*
	HFnu	50.32	33.97-66.37	62.68	55.85-74.36	0.004*
	LF:HF	0.99	0.51-1.94	0.59	0.34-0.79	0.004*

*statistically significant

Comparison of post-intervention HRV indices between supine rest group and Yoga Nidra group is shown in Table 5. Statistical analyses by Mann Whitney U tests showed that the median values of time-domain indices after the intervention were not significantly different. Among the frequency domain indices, the median values of HF and HFnu were significantly higher, whereas, values of LFnu and LF:HF ratio were significantly lower in Yoga Nidra group compared to supine rest group ($p<0.05$). However, the higher values of LF and TP in Yoga Nidra group than supine rest group was not statistically significant.

DISCUSSION

The purpose of the study was to measure the baseline HRV indices of young healthy volunteers and assess the changes brought about by Yoga Nidra relaxation. It was found that Yoga Nidra relaxation produced significant changes from baseline in all the time domain and frequency domain indices of HRV with increase in SDNN, RMSSD, NN50, pNN50, LF, HF, TP and HFnu, and decrease in LFnu and LF: HF ratio. In contrast, simple supine rest did not bring about significant changes in all domains of HRV. These findings indicated a considerable improvement in HRV pointing to a significant parasympathetic modulating effect of Yoga Nidra relaxation in comparison to simple supine rest.

In comparison to the post-intervention findings of supine rest, significantly higher values of HF and HFnu and reductions in LFnu and LF: HF ratio were observed after Yoga Nidra relaxation. Increase in HF and HFnu suggest a strong parasympathetic modulation, while reductions in LFnu and LF: HF ratio suggest possible decline in sympathetic activity and shift of symaptho-vagal balance towards parasympathetic mode. All these findings advocate a superior parasympathetic modulating response of Yoga Nidra than supine rest.

Comparison of post-intervention HRV indices between the two groups showed significant differences in HF, HFnu, LFnu and LF:HF ratio of frequency domains but did not show significant difference in time domain indices. As per the Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology guidelines, frequency domain recording is preferred to time domain recording in short-term analysis of HRV.[2] Thus the significant variations in the major frequency domain indices point to a better HRV indicating a superior shift of autonomic balance to parasympathetic mode, as seen after Yoga Nidra relaxation.

These findings are in accordance with the study done by Markil et al[10] in Florida in which Yoga Nidra relaxation produced significant variations from baseline HRV values in university students. The HF increased whereas LF and LF:HF ratio decreased in the Yoga Nidra post-relaxation period.[10] The study showed that Yoga Nidra shifts the autonomic balance to the parasympathetic system as demonstrated by significant changes in the HRV indices.

The results of our study also supports the finding of the study by Nagendra et al[11] in India, in which a yoga intervention group that underwent practice of integrated yoga for five months showed significant improvement in HRV as indicated by increased SDNN/RMSSD and HFnu; and reduction in LFnu and LF: HF ratio. No significant alteration was seen in the controls. The results suggested that the practice of integrated yoga brought about an increased parasympathetic activity as shown by an improved HRV.

Similar results were seen in an interventional study by Pal et al[12] in Puducherry, India where cardiovascular autonomic functions were assessed in apparently healthy, male medical students after a short-term practice of relaxation therapy. Significant changes from baseline in HRV indices were documented in the relaxation group with increase in mean RR, RMSSD, NN50, pNN50, HFnu, TP (ms^2) and a decrease in LF:HF ratio. No significant alteration was observed in the control group. The results demonstrated an improvement in autonomic balance towards parasympathetic activity after a short-term practice of relaxation therapy.

Similar findings have been reported by An et al,[13] Patra et al[14] and Vempatti et al[15,16] where various yoga based guided relaxation techniques in the form of cyclic meditation, *Shavasana* have been shown to exert parasympathetic modulating effects on various HRV indices.

Except the study done by Vempatti et al,[16] which recruited volunteers with no previous experience of yoga or relaxation techniques, all the other studies discussed above recruited volunteers who have either been regular practitioners of yoga/relaxation or even if non-practitioners, have been tested only after minimum of 6 weeks of practice of the technique. Our study has included volunteers inexperienced in yoga or related techniques and all the participants have undergone intervention right after the initial session of introduction and demonstration of the technique. As the volunteers were new to yoga and related practices and were tested without a considerable pre-training or practice, it appears that Yoga Nidra can prove to be an effective short-term means of relaxation even in people inexperienced in such techniques. The findings can provide credibility for use of this form of short-term relaxation technique as a means of stress-busting for students during stressful times like examinations.

Physical activity is known to boost HRV.[17] The levels of physical activity of the participants was not considered in the study and might have influenced the results. However, the participants were asked to refrain from strenuous physical activity for 24 hours before the test.

CONCLUSION

Yoga Nidra, a yoga based guided relaxation technique produced significant improvement in HRV parameters than simple supine rest in young and healthy volunteers, which represents increased parasympathetic drive and decreased sympathetic activity. As increased parasympathetic dominance suggests a better ability to relax, Yoga Nidra caused a superior short-term relaxation than simple supine rest in young and healthy male volunteers.

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