Original Research Paper

Volume - 12 | Issue - 11 | November - 2022 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Physiology

EFFECT OF MODIFIED ANULOMA VILOMA PRANAYAMA ON HEART RATE VARIABILITY AND CARDIOVASCULAR PARAMETERS IN HEALTHY MALE ADULTS

G Sunil Naik* Assistant Professor, Physiology, AIIMS, Mangalagiri *Corresponding Author

GS Gaur Professor, Physiology, JIPMER, Puducherry

GK Pal Senior Professor, Physiology, JIPMER, Puducherry

ABSTRACT Regular practice of pranayama helps in maintaining the cardiovascular and respiratory health. The physiological effects produced vary on the type of pranayama performed. Conventional anuloma viloma pranayama with increased duration of breath holding is an advanced method not suitable for beginners and can lead to undesired effects. A simpler form of pranayama for beginners involves, equal phases of inhalation, breath holding, and exhalation. The breathing exercise carried out in our study, is a modified form of Anuloma Viloma Pranayama with equal phases of inspiration, breath holding, and expiration, standardized by Pal et al. We wanted to study the effect of a modified form of Anuloma Viloma Pranayama on Heart rate variability and cardiovascular parameters in healthy male volunteers. This study was carried out in ACYTER, Department of Physiology, Jawaharlal Institute of Postgraduate Medical Education and Research, Puducherry. Ninety nine healthy, male volunteers were randomized into control group, n=50 and modified pranayama group (study), n=49. Modified Pranayama training was given to study group for 30 minutes a day, 5 times/week for a total period of 12 weeks, under supervision of certified yoga trainers. No intervention was given for control group. Heart rate variability (HRV) indices and cardiovascular parameters like Heart rate (HR), Systolic blood pressure (SBP), Diastolic blood pressure (DBP) were recorded at baseline and after 12 weeks. HR, SBP, DBP and HRV indices showed a significant improvement ($P<0.05$) in the study group after 12 weeks of modified pranayama. No significant change was observed in the control group. Hence, we conclude that 12 weeks of modified Anuloma viloma pranayama practice improves the Heart rate variability in Healthy Male Adults.

KEYWORDS : Pranayama, Heart rate variability, Blood pressure, Breath holding.

INTRODUCTION

Yoga is a physical, mental, and spiritual discipline that has its roots in ancient India. The purpose of yoga is to harmonize the physical and mental health[1,2]. The ancient science of yoga is practiced for many decades in India and has stirred enormous interest all over the world due to its applications in the field of preventive and therapeutic research. The awareness regarding the benefits of various yogic techniques including pranayama is gaining popularity among the educated public as well as the scientific community[3].

Pranayama is the fourth limb of Ashtanga yoga as mentioned by Patanjali. Patanjali has defined pranayama as a "Regulation of the incoming and outgoing flow with retention of breath"[4]. "Prana" means life force which is the breath we inspire and "ayama" means to "extend" or "regulate". Prana is not the same as breath. It is the total energy of our body system[5].

There are different methods of pranayama varying from single nostril breathing to alternate nostril breathing. It consists of three phases: "Purak (inhalation), Kumbhak (retention) and Rechak (exhalation)" and these phases can be practiced in either slow or fast manner[6]. The physiological effects produced vary on the type of pranayama performed[7–9]. Previous studies have shown that slow and fast type of pranayama has different physiological effects in healthy subjects[7]. Also, pranayama has a variable effect on cardiac and pulmonary function parameters[10].

Shallow breathing replenishes air only at the base of the lungs in contrast to deep breathing that replenishes air in all parts of the lung[8]. Slow deep breathing can be practiced both in the sitting posture and lying down posture. Regular practice of pranayama helps in maintaining the cardiovascular and respiratory health. It decreases the effect of stress and strain on the body, thereby, improves the physical and mental health.

Slow, deep breathing causes a decrease in Heart rate, blood pressure, oxygen consumption and an increase in the parasympathetic activity, increased activity of theta waves in EEG, leading to a state of alert consciousness[11]. Slow, deep breathing leads to a reduction in heart rate with a concomitant decrease in both systolic and diastolic blood pressure[9]. Previous studies have demonstrated that regular practice of slow, deep breathing increases baroreflex sensitivity and decreases the oxygen consumption of the cardiac tissues[12,13].

Conventional anuloma viloma pranayama with inhalation, breath holding, and exhalation in the ratio of 1:4:2 is an advanced method not suitable for beginners. Also the increased duration of breath holding (kumbhaka) can lead to undesired effects[14]. The increased duration of kumbhaka practiced in anuloma viloma pranayama is hard to practice for beginners and prolonged breath holding is associated with an increased risk of cerebral hypoperfusion in unhealthy individuals. A simpler form of pranayama for beginners involves, equal phases of inhalation, breath holding, and exhalation. It is a form of Samvritti pranayama recommended for beginners and persons with "Vata" imbalance[15].

The slow, deep breathing exercise carried out in our study, is a modified form of anuloma viloma pranayama (alternate nostril breathing), with equal phases of inspiration, breath holding, and expiration (1:1:1 ratio).

SUBJECTS AND METHODS

After obtaining approval from Jawaharlal Institute of Postgraduate Medical Education and Research (JIPMER) Scientific Advisory Committee and Human Ethics Committee, we recruited 100 healthy volunteers for our study. Healthy male volunteers in the age group of 18–30 years were included in the study. Individuals who were unable to perform breathing exercise due to reasons such as nasal pathology including deviated nasal septum, sinusitis and those with a history of chronic respiratory disorder, cardiac disorder along with diabetics, hypertensives, smokers, alcoholics, and athletes were excluded from the study.

The total of 100 subjects were recruited and divided equally into control and study groups using simple randomization technique (random numbers generated using computer software). The control and study group consisted of 50 volunteers each. During the study, one volunteer opted out of the study group due to personal reasons.

The baseline parameters were recorded before the start of modified breathing exercise training. The subjects were advised to come at least 1 hour after light breakfast preferably in light clothing. They were instructed not to perform any intensive exercise and to avoid taking any hot or cold beverage, 30 minutes prior to recording of parameters. Anthropometric parameters like Height, Weight, BMI and Waist Hip ratio (WHR) were measured. Basal cardiovascular parameters including Heart rate (HR), Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) were measured using digital BP monitor (Citizen - CH 432B, Japan), after 10 minutes of rest in the lying down posture. The Heart Rate Variability (HRV) recording was done with BIOPAC Sytems, Inc MP36 with provision of four channels, with the subject in supine posture after 10 minutes of rest.

The Lead II ECG was recorded for 5 minutes and the HRV parameters were calculated with the reading obtained.

Modified slow breathing exercise training

Anuloma viloma pranayama is a form of slow, rhythmic, alternate nostril breathing. Traditional anuloma viloma consists of inhalation, kumbhaka, and exhalation in the ratio of 1:4:2. Our slow breathing exercise is a modified version of the anuloma viloma pranayama in the ratio of 1:1:1, which was standardized by Pal et al. The control group did not undergo any form of breathing exercise. The study group was given modified Anuloma villoma pranayama training under the guidance of a trained, certified yoga instructor at the Advanced Centre for Yoga Therapy, Education and Research (ACYTER), JIPMER. Practice sessions were conducted 5 days/week in the morning for 30 minutes under our direct supervision and subjects were motivated to practice the same at their home daily on the other 2 days. Modified pranayama training was given for a total duration of 12 weeks. Attendance register was maintained for yoga training sessions, and the data was obtained only from subjects whose attendance was at least 80%.

The technique of Modified Anuloma Viloma pranayama

The right nostril is blocked with the right thumb, and air is breathed in through the left nostril slowly for a count of 6 secs. Then, with the help of right index finger, the left nostril is also blocked (both nostrils closed), and the breath is held for a count of 6 secs. Now the right thumb is released from the right nostril, and air is breathed out for a count of 6 secs. Air is breathed in again for a count of 6 secs through the right nostril followed by breath holding for 6 secs and finally breathing out through the left nostril for 6 secs, thus completing one cycle [Figure 1].

The total time for one cycle is 36 s and each cycle is repeated for 30 minutes with a rest of 5 minutes in between. The breath count duration was maintained with the help of a metronome. All the parameters were again recorded after 12 weeks of modified pranayama training, and statistical analysis of the obtained data was performed.

Statistical Analysis

Data were summarized using descriptive statistics such as mean and standard deviation for all the recorded parameters. P value <0.5 was considered significant with study power of 80% and the level of significance was kept at 5%. The normality of the continuous data was tested using Shapiro wilk test. The comparison of anthropometric, basal cardiovascular parameters, and HRV parameters between the control and study group was carried out using an unpaired t-test. The intragroup comparison of anthropometric, basal cardiovascular parameters and HRV parameters was carried out using paired t-test.

RESULTS

A total of 100 volunteers were recruited for the study and divided equally into 50 in study and 50 in control group using simple randomization technique. One volunteer opted out of the study group due to personal reasons. The control group did not undergo any intervention whereas the study group underwent 12 weeks of modified slow breathing exercise.

The baseline anthropometric, cardiovascular parameters and HRV parameters between the control and study group showed no significant difference. Hence, they can be considered comparable to the present study. After 12 weeks of slow breathing exercise, the changes in body mass index (BMI) and waist-hip ratio were statistically significant, but the reduction in the mean values do not appear to be clinically significant (0.16 kg/m2, 0.003) in the day-to-day life [Table 1].

There was a significant reduction in HR from baseline compared to the control group. The SBP and DBP values following 12 weeks of slow, deep breathing exercise also showed a statistically significant reduction [Table 1].

Among the HRV parameters, the time domain indices SDNN and RMSSD showed a statistically significant improvement after 12 weeks of modified, slow breathing exercise. The frequency domain parameters LFnu and LF/HF ratio showed a statistically significant reduction after 12 weeks of modified, slow breathing exercise while, HFnu, showed a statistically significant improvement after 12 weeks of modified slow breathing exercise. [Table 2]

DISCUSSION

Pranayama is a bridge that connects the mind and body through the breath that we take. The different lengths of inhalation, exhalation, and breath holding are thought to be the cause of pranayama's distinct physiological and psychological impacts. Additionally, it depends on the degree to which the practising person uses their mouth, nostrils, laryngeal muscle constriction, glottis posture, and tidal capacity.[16].

The pranayama carried out in our study was a modified form of anuloma viloma pranayama standardized by Pal et al.[9] with equal phases of inspiration, breath holding, and expiration (1:1:1 ratio).

There was a significant reduction in HR, SBP, and DBP following the practice of 12 weeks of slow deep breathing exercise. Parasympathetic tone is the predominant determinant of resting HR and a decrease in HR and BP indicates a shift toward parasympathetic activity or a decrease in sympathetic activity[17].

The parasympathetic dominance that is seen in a relaxed state of mind causes a decrease in resting heart rate and a decrease in the sympathetic tone of skeletal blood vessels, which lowers peripheral vascular resistance and lowers blood pressure. SBP may have dropped as a result of the end organs' diminished reactivity to circulating noradrenaline following a relaxed state after practise of our modified breathing exercise.[18].

Although there was a statistically significant decrease in the pre and post values for HR, SBP, and DBP, the effect magnitude was not significant. It's possible that the clinical significance won't follow from the statistical significance. It remains to be known if extending pranayama for an additional 12 weeks would have resulted in a statistically and clinically meaningful decline in the size of the aforementioned parameters.

Heart Rate Variability is an established tool for assessing sympathovagal balance and can be estimated by both time domain and frequency domain measures. Time domain measures can be easily performed and interpreted but they aren't as effective as frequency domain in analyzing the HRV pattern[19].

After 12 weeks of modified slow breathing exercise, the time domain parameters SDNN and RMSSD showed a statistically significant improvement. SDNN/RMSSD ratio can be used as a substitute for LF/HF ratio for assessing sympathovagal balance[20,21]. The frequency domain indices LFnu, HFnu and LF/HF ratio showed a statistically significant change after 12 weeks of modified slow breathing exercise. The parasympathetic activity is inhibited during controlled breathing exercise which is reflected by a decrease in HFnu and an increase in LFnu, LF/HF ratio[22].

The respiratory and cardiovascular systems are linked through the vagal nerve regulation process. Because afferent impulses control neuronal activity, a change in one system may have an impact on the other and its functions[23]. Even a brief duration of pranayama practise can result in positive changes in the cardiovascular system and boost baroreceptor sensitivity[24,25].

The modified Anuloma villoma pranayama practiced in our volunteers showed a favorable response in heart rate variability. Breath holding should only be practised under supervision with a qualified instructor because doing it wrongly for extended periods of time can cause significant brain damage from anoxia. The practical challenge faced by illiterate subjects when practising the unequal ratio (1:4:2) deserves special attention. The equal breathing ratio (1:1:1) used in our study reduces the extra concentration required to focus on the unequal breathing ratio (1:4:2) in conventional Anuloma viloma pranayama, allowing the participant to focus more on the breathing than on the ratio of breathing.

According to yogic literature, a subject should begin pranayama without holding their breath for at least two months before introducing it gradually. This shows how challenging holding the breath may be for pranayama newbies. The aforementioned factor causes the advantages of breath holding to be delayed by at least one or two months. It is simpler for novices to practise and benefit from breath holding straight away, saving significant time, thanks to the equal distribution of inhalation, exhalation, and breath holding in our research.

Our findings do support the advantages of alternate nostril, slow, uniform ratio breathing exercises in reducing heart rate variability. The results are comparable to those of traditional Anuloma viloma

pranayama, but without the challenges of varied ratios and long breath holds.

Further research is required to determine whether our modified breathing exercise is beneficial in lowering blood pressure and BMI to a clinically meaningful level. Future research might be planned by extending the study duration of pranayama to see whether any clinically meaningful changes in anthropometric and blood pressure parameters can be obtained.

CONCLUSION

Numerous breathing techniques and yoga asanas have been used to keep the sympathovagal system in balance and to lessen sympathetic overactivity that has developed as a result of an unbalanced lifestyle. The urgent demand, however, is for a single, straightforward instrument that is ideal for beginners and those with medical problems. Our modified breathing exercise is a single, straightforward, yet powerful tool for lowering stress and rebalancing the sympathovagal balance more in favour of parasympathetic predominance. Everyone, including those with minimal training to expert pranayama practioners, can utilize it. Hence, it may be stated that the modified form of Anuloma villoma pranayama with an equal ratio of inhalation, breath holding, and exhalation adopted by us is effective in maintaining sympathovagal balance and improving the heart rate variability.

The modified slow breathing exercise did not have any negative side-effects, and the participant showed good compliance.

Table 1: Comparison of Anthropometric and cardiovascular parameters before and after 12 weeks of Modified Anuloma Viloma Pranayama in the study group.

Parameters	Baseline (n=49)	Post 12 weeks (n=49)
Anthropometric		
BMI (Kg/m2)	25.45 ± 3.51	25.35 ± 3.39
WHR (ratio)	0.90 ± 0.08	0.89 ± 0.08
Cardiovascular		
HR (bpm)	76.43 ± 7.97	75.27 ± 6.86*
SBP (mmHg)	121.84 ± 10.16	120.65 ± 8.67*
DBP (mmHg)	76.84 ± 8.08	76.06 ± 7.30*

Analysis done by student's paired t-test; Values are expressed as mean ± SD; *p<0.05 (significant); BMI: Body Mass Index; WHR: Waist Hip Ratio; HR: Heart Rate; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure.

Table 2: Comparison of Heart rate variability parameters before and after 12 weeks of Modified Anuloma Viloma Pranayama in the study group

HRV Parameters	Baseline (n=49)	After 12 weeks (n=49)
HF (nu)	51.19 ± 11.43	52.42 ± 11.25*
LF (nu)	48.10 ± 11.43	47.57 ± 11.21)
LF/HF ratio	1.16 ± 1.20	1.15 ± 1.27*
Mean RR (ms)	839.17 ± 166.11	843.15 ± 164.38*
SDNN (ms)	57.44 ± 22.19	76.14 ± 24.65*
RMSSD (ms)	48.89 ± 18.37	53.78 ± 20.32*
SDNN/RMSSD ratio	1.30 ± 0.60	1.59 ± 0.66*

Analysis done by student's paired t-test; Values are expressed as mean ± SD; *p<0.05 (significant); LF nu: Low Frequency normalized units; HF nu: High Frequency normalized units; Mean RR: Mean RR intervals; SDNN: Standard Deviation of NN intervals; RMSSD: Root Mean Square of Successive Differences.

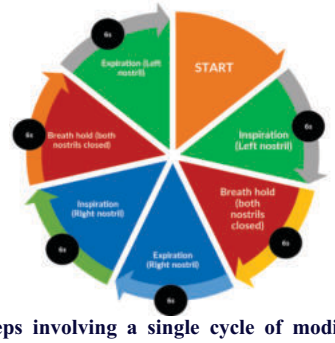

Figure 1: Steps involving a single cycle of modified Anuloma villoma pranayama

Limitations and future scope

Double-blinded conditions could have been attempted to avoid a potential rater bias in our randomised control research. To test if any clinically relevant results might be produced with regard to blood pressure and BMI, the breathing practise duration could be prolonged beyond 12 weeks.

REFERENCES:

1. Madanmohan, Mahadevan SK, Balakrishnan S, Gopalakrishnan M, Prakash ES. Effect of six weeks yoga training on weight loss following step test, respiratory pressures, handgrip strength and handgrip endurance in young healthy subjects. Indian J Physiol Pharmacol. 2008 Jun;52(2):164–70.
2. Khalsa SBS. Yoga as a therapeutic intervention: a bibliometric analysis of published research studies. Indian J Physiol Pharmacol. 2004 Jul;48(3):269–85.
3. Udupa K, Madanmohan, Bhavanani AB, Vijayalakshmi P, Krishnamurthy N. Effect of pranayam training on cardiac function in normal young volunteers. Indian J Physiol Pharmacol. 2003 Jan;47(1):27–33.
4. Vivekananda, Jha VK, Patañjali, Patañjali. Patanjalis yoga sutras by Swami vivekananda. 1st ed. Solar books; 2015. 256 p.
5. The Study and Practice of Yoga by Swami Krishnananda [Internet]. [cited 2021 Jun 30]. Available from: https://www.swami-krishnananda.org/patanjali.html
6. Chodzinski J. The Effect of Rhythmic Breathing on Blood Pressure in Hypertensive Adults. JUR [Internet]. 2000 [cited 2020 Mar 31];1(6). Available from: https://ufdc.ufl.edu/UF00091523/00031
7. Madanmohan, Vijayalakshmi, Udupa K, Prakash ES, Bhavanani A. Review of Shavasana Studies Conducted at JIPMER During 2001-2002y. Yoga Mimamsa. 2003 Apr 1;35:26–34.
8. Bijlani RL, Manjunatha S. Understanding medical physiology: a textbook for medical students. 4th ed. New Delhi: Jaypee Bros. Medical Publishers; 2011. 810 p.
9. Pal GK, Velkumary S, Madanmohan. Effect of short-term practice of breathing exercises on autonomic functions in normal human volunteers. Indian J Med Res. 2004 Aug;120(2):115–21.
10. Veerabhadrappa SG, Herur A, Patil S, Ankad RB, Chinagudi S, Baljoshi VS, et al. Effect of yogic bellows on cardiovascular autonomic reactivity. Journal of Cardiovascular Disease Research [Internet].2011 Oct [cited 2020 Mar 31];2(4):223–7. Available from : http://www.jcdronline.org/article/211
11. Jerath R, Edry JW, Barnes VA, Jerath V. Physiology of long pranayamic breathing: neural respiratory elements may provide a mechanism that explains how slow deep breathing shifts the autonomic nervous system. Med Hypotheses. 2006;67(3):566–71.
12. Bernardi L, Gabutti A, Porta C, Spicuzza L. Slow breathing reduces chemoreflex response to hypoxia and hypercapnia, and increases baroreflex sensitivity. J Hypertens. 2001 Dec;19(12):2221–9.
13. Bhavanani AB, Sanjay Z, Madanmohan. Immediate effect of sukha pranayama on cardiovascular variables in patients of hypertension. Int J Yoga Therap. 2011;(21):73–6.
14. Bhargava R, Gogate MG, Mascarenhas JF. Autonomic responses to breath holding and its variations following pranayama. Indian J Physiol Pharmacol. 1988 Dec;32(4):257–64.
15. Pandey DAK, Sharma DAK, Pandey A. IMPORTANCE AND BENEFITS OF PRANAYAMA- A LITERARY REVIEW. World Journal of Pharmaceutical Research. 7(11):8.
16. Freitas DA, Holloway EA, Bruno SS, Chaves GS, Fregonezi GA, Mendonça KM. Breathing exercises for adults with asthma. Cochrane Database of Systematic Reviews [Internet]. 2013 [cited 2020 Mar31];(10).Available from:https:// www. cochranelibrary. com/cdsr/doi/10.1002/14651858.CD001277. pub3/full.
17. Patil SG, Mullur LM, Khodnapur JP, Dhanakshirur GB, Aithala MR. Effect of yoga on short-term heart rate variability measure as a stress index in subjunior cyclists: a pilot study. Indian J Physiol Pharmacol. 2013 Jun;57(2):153–8.
18. Sharma VK, Trakroo M, Subramaniam V, Rajajeyakumar M, Bhavanani AB, Sahai A. Effect of fast and slow pranayama on perceived stress and cardiovascular parameters in young health-care students. Int J Yoga. 2013 Jul;6(2):104–10.
19. Berntson GG, Bigger JT, Eckberg DL, Grossman P, Kaufmann PG, Malik M, et al. Heart rate variability: origins, methods, and interpretive caveats. Psychophysiology. 1997 Nov;34(6):623–48.
20. Balocchi R, Cantini F, Varanini M, Raimondi G, Legramante JM, Macerata A. Revisiting the potential of time-domain indexes in short-term HRV analysis. Biomed Tech (Berl). 2006 Oct;51(4):190–3.
21. Sollers JJ, Buchanan TW, Mowrer SM, Hill LK, Thayer JF. Comparison of the ratio of the standard deviation of the R-R interval and the root mean squared successive differences (SD/RMSSD) to the low frequency-to-high frequency (LF/HF) ratio in a patient population and normal healthy controls. Biomed Sci Instrum. 2007;43:158–63.
22. Sasaki K, Maruyama R. Consciously controlled breathing decreases the high-frequency component of heart rate variability by inhibiting cardiac parasympathetic nerve activity. Tohoku J Exp Med. 2014 Jul;233(3):155–63.
23. Pramanik T, Sharma HO, Mishra S, Mishra A, Prajapati R, Singh S. Immediate effect of slow pace bhastrika pranayama on blood pressure and heart rate. J Altern Complement Med. 2009 Mar;15(3):293–5.
24. Bhavanani AB, Madanmohan, Sanjay Z, Basavaraddi IV. Immediate cardiovascular effects of pranava pranayama in hypertensive patients. Indian J Physiol Pharmacol. 2012 Sep;56(3):273–8.
25. Bhavanani AB, Madanmohan, Sanjay Z. Immediate effect of chandra nadi pranayama (left unilateral forced nostril breathing) on cardiovascular parameters in hypertensive patients. Int J Yoga. 2012 Jul;5(2):108–11.