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Study on the effect of yoga on autonomic functions in healthy volunteers

Dr. Sonika Choudhary
Assistant Professor, Department of Physiology, R.N.T. Medical College, Udaipur, Rajasthan, India

Abstract
Background: Research studies have demonstrated that yoga can modulate autonomic functions. Hence, the current study was designed to assess the effect of yoga on autonomic functions.
Method: 100 healthy volunteers (146 M; 54 F) from age group (17-26) years were included in the study. They practiced some yogic exercises including Asanas, Pranayam & relaxation techniques daily one hour for 3 months. The autonomic function tests to measure the parasympathetic reactivity were deep breathing test (DBT), lying to standing test (LST) and valsalva ratio (VR). For sympathetic reactivity hand grip test (HGT) and cold pressure test (CPT) were performed.
Result: Heart rate response to deep breathing (E: I ratio) increased significantly while 30:15 ratio during LST and valsalva ratio (VR) did not change significantly after the yoga training (P>0.05). In Isometric handgrip test (IHG test) rise in SBP (ΔSBP) was not significantly altered after 3 months of yoga training whereas rise in DBP (ΔDBP) was significantly decreased in response to IHG test. Range/response (Δ) of systolic blood pressure and diastolic blood pressure during cold pressor test (CPT) was found to be significantly reduced
Conclusion: These findings suggest that, Yoga training improved autonomic functions in healthy volunteers.

Keywords: yoga, autonomic functions, DBT, E: I ratio, VR, HGT, CPT

Introduction

Yoga a mind-body technique, deals with the evolution of humanity. This evolution includes all aspects of one's being, from bodily health to self-realization. Yoga cultivates the ways of maintaining a balanced attitude in day-to-day life and endows skill in the performance of one's actions (B.K.S. Iyengar, Astadala Yogamala).

The most popular branch of yoga is Hatha Yoga, which consists of a combination of postural exercises (Asanas), relaxation and voluntary breathing exercise (Pranayamas).

Scientific studies have shown that the practice of yoga has beneficial effect on our physiological functions. Selvamurthy *et al.* (1983) [1] found that six months of yoga resulted in an autonomic shift towards the parasympathetic nervous system. Practicing yoga regularly can reduce the physiological arousal and develops the ability to adapt to a demanding situation [2]. Mirabai *et al.* (2017) [3] has reported that the regular practice of a set of yoga training blunted the sympathetic drive and lateralised the autonomic function towards parasympathetic control.

The effect of regular practice of yoga on autonomic functions is important to better understand its effects on healthy individuals and to provide the basis for the possible use of yoga techniques as alternative therapy.

In this respect the present study evaluated the effect of regular practice of Yoga on Autonomic function test.

Material and Method

This study was conducted on 100 healthy students and volunteers between age of 17-26 years of either sex (M78:F22) from Dr. S.N. Medical College, other academic colleges and yoga centres.

Subjects included in the study were non-alcoholic, non-smokers, not taking any type of medication and were having similar dietary habits.

Subjects involved in heavy physical exercise and previous experience of yoga training, history of any major medical illness and major surgery were not included in the present study.

Subjects were allocated to practice yoga for 3 months.

The volunteers and students were briefed about the outcome of study and a written consent was obtained from them.

Subjects were given yogic training for 1 hour under the guidance of qualified yoga instructor for 3 months regularly. The yogic schedule includes – asanas (postural exercise), relaxation techniques and pranayama (breathing exercise).

Table 1: Details of Yogic Practices

Asanas
(A) Standing
1. Ardhakatichakrasana (lateral arc pose) 2. Padahastasana (forward bend pose)
(B) Sitting
Ardhamatsyendrasana (half-spinal twist pose) Pschimottanasana (back stretch pose)
(C) Lying on stomach (prone)
1. Makarasana (crocodile pose)
2. Bhujangasana (cobra pose)
3. Shalabhasanas (locust pose)
4. Dhanurasana (bow pose)
(D) Lying on back (supine)
1. Utthanpadasana (straight leg raising)
2. Ardhahalasana (plough pose)
3. Pavanmuktasana (wind relieving pose)
4. Setubandhasana (bridge pose)
(E) Deep Relaxation in Shavasana (Corpse Pose)
(F) Pranayama (Breathing Practices)
1. Kapalbhati Pranayama
2. Anulom-VilomPranayama (alternate nostril breathing)
3. Bhramari (honeybee sound during expiration)

Asanas were performed for 40 min. duration. Each subject performed every asana 3 times. The asanas were followed by a meditation/ deep relaxation technique in shavasana (corpse posture) for 5 min. & pranayama (breathing exercise) were performed in the last 15 minutes. The set of asanas & pranayama included in the course are listed in Table -1

Parameters

First anthropometric characteristics (body weight, height, and BMI) were evaluated using an anthropometric scale. (Table-2)

Table 2: Anthropometric measurements

Parameter	Yoga Group	
	Pre	Post
Height (m)	1.69±0.07	1.69±.07
Weight (Kg)	60.63±8.91	60.29±8.61
BMI (Kg/m^2)	21.24±2.72	21.07±2.58

Then before starting yoga training & after end of 3 months following parameters were measured.

Autonomic function test

To measure the parasympathetic activity, deep breathing test (DBT), lying to standing test (LST), valsalva ratio (VR) and for sympathetic activity hand grip test (HGT) and cold pressure test (CPT) were performed following the procedures described by Banister and Mathias (1992) [4]. All these test employed in the study were simple, reliable and non-invasive.

1. Deep breathing test (DBT): The test was performed in supine position. Subject was asked to lie down comfortably with ECG leads attached to ECG machine till his heart rate was stabilized. Then he was asked to breathe deeply at a rate of 6 breaths per minute, allowing 5 sec each for inspiration and expiration, by counting "IN-2-3-4-5-OUT-2-3-4-5" hand signal were also given to maintain the rate and timing of the breathing. Along with deep breathing ECG recording was also done in IInd limb lead. It was explained that breathing should be smooth, slow and deep.
   The parasympathetic activity (heart responses to deep breathing) was measured by calculating E : I (Expiration : Inspiration) ratio.
   E: I ratio = average of maximum R-R interval during expiration / average of minimum R-R interval during inspiration.
2. ii) Lying to standing test (LST): Before the test was performed, the subject was allowed to lie down for 5 min in supine position. ECG leads were connected for recording of lead II ECG. The subject was instructed to stand within 3 seconds from lying position.
   30:15 R-R ratio was calculated as the ratio of longest R-R interval around 30th beat and shortest R-R interval around 15th beat from the ECG recording.
3. Valsalva ratio (VR): For valsalva maneuver subject was allowed to sit in erect posture in a chair with a rubber clip over the nose. ECG leads were connected and he was asked to blow out or to expire forcefully in rubber tube of mercury manometer and to create a pressure of 40 mm Hg and maintain it for 15 sec. Simultaneously an ECG was recorded during VM and 30 sec after finishing it in limb lead II. From the ECG recording, Valsalva ratio was calculated using the formula -
   Valsalva ratio = longest R-R interval after maneuver / shortest R-R interval during maneuver.

The following tests were done to assess sympathetic reactivity.

1. Hand grip test (HGT): The maximum voluntary contraction (average of three measurements) was obtained using a handgrip dynamometer then the subjects was asked to grip the dynamometer with their dominant hand at 30% of their maximum voluntary capacity for 5 minutes in sitting position. During the test procedure BP was recorded at every minute with the help of sphygmomanometer on the non- exercising arm. The rise in diastolic BP at the point just before the release of handgrip was taken as the index of response to HGT.
2. Cold pressure test (CPT): The subject was asked to immerse his hand in cold water at 4-6^{0}C up to the wrist joint for 2 minutes. After 2 minutes subject was allowed to remove the hand. Simultaneously BP was recorded on other arm before starting of the test and towards the end of the test. Increase in systolic and diastolic blood pressure from the baseline value (average of two values) to maximal value, known as the range or response (Δ), was obtained.

Analysis of data

Paired t test was used to compare the datas. P value <0.05 was considered significant.

Observation and Result

Yoga training resulted into significant increase in E: I ratio (heart rate response to deep breathing) while 30:15 ratio during LST and valsalva ratio (VR) during VM did not change significantly after the yoga training (P>0.05).

Table 3: Parasympathetic activity before and after yoga training

Parameter	Pre	Post
E: I ratio (DBT)	1.42±0.16	1.49±0.19*
30:15 ratio (LST)	1.53±.19	1.55±0.2
VR	1.69±0.29	1.77±0.26

*P<.05 on comparing pre and post yoga group

Isometric handgrip test (IHG test) increased the systolic blood pressure (SBP) but this rise in SBP (ΔSBP) was not significantly altered after yoga training whereas rise in DBP (ΔDBP) was significantly decreased from 19.9±7.2 mm Hg to 14.4±4.45 mmHg in response to IHG test.

In yoga group range/response (Δ) of systolic blood pressure during cold pressor test (CPT) was found to be significantly reduced from 16.73±5.45 mmHg to 12.98±4.4 mm Hg (P<0.01) and diastolic blood pressure from 12.86±4.75 mmHg to 8.8±3.19 mm Hg (P<0.01)

Table 4: Sympathetic activity before and after yoga training

Parameter	Pre	Post
ΔSBP (HGT)	22.32±7.1	20.22±6.1
ΔDBP (HGT)	19.98±7.28	14.46±4.45**
ΔSBP (CPT)	16.73±5.45	12.98±4.4**
ΔDBP (CPT)	12.86±4.75	8.8±3.19**

**P<.01 on comparing pre and post yoga group.

Discussion

Present study showed a significant (P<.05) increase in heart rate response to deep breathing (E: I ratio). Normally, in adults the difference in heart rate varies from 10-15 and a value less than 10 is regarded as abnormal. E: I ratio decreases with increasing age (Bannister R *et al.*, 1992) [4].

A significant rise in E: I ratio after yoga indicates an increase in vagal activity, as the change in heart rate during breathing is mainly due to the change in vagal activity (Ganong WF, 2001) [5]. Our finding corroborate with the observations of Pal GK *et al.* (2004) [6] and Mourya M *et al.* (2009) [7].

30:15 ratio and valsalva ratio (VR) indicate intact baroreceptors mediated increase or decrease in heart rate in response to sudden standing from lying down position and Valsalva maneuver respectively so these tests are markers of parasympathetic reactivity and baroreflex function.

In our study the 30:15 ratio and valsalva ratio (VR) did not show any change after 3 months of training although increasing trend was observed in these parameters. This may be due to the shorter duration of training schedule, which was not adequate enough to cause changes in the sensitivity of baroreceptors to affect these parameters. Similar result was also shown by Pal GK *et al.* (2004) [6] and Khanam *et al.* (1996) [7] for VR and Sahoo *et al.* (2010) [8] for 30:15 ratio.

Isometric handgrip test (IHG test) provides pressor stimuli to cardiovascular system through efferent sympathetic pathways with a resultant increase in HR and BP (Bannister R *et al.*, 1992) [4]. Normally, IHG test increases DBP by 16 mm Hg or more and a rise of 10 mm Hg or less indicates abnormal cardiovascular reflex regulation (Bannister R *et al.*, 1992) [4]. In our subjects, IHG test increased the mean DBP by 19.9±7.2 mm Hg before yoga training. After yoga training, rise in DBP (ΔDBP) was significantly decreased to 14.4±4.45 mmHg in response to IHG test but rise in SBP (ΔSBP) was not significantly altered in response to IHG test after yoga training.

After yoga training change in SBP and DBP (ΔSBP and ΔDBP) during cold pressor test was found to be significantly reduced (P<0.01). This shows that practice of Yoga is well-demonstrated to reduce the physical effects of stress on the body (Brown RP *et al.*, 2005) [10]. Madanmohan *et al.* (2002) and Sharma G *et al.* (2009) studied modulation of CPT-induced stress by shavasana wherein they found a significant reduction in BP. This reduction was explained on the basis of an increase in parasympathetic tone and reduction in sympathetic tone.

Conclusion

The present study shows that 3 months yoga training produces a significant improvement in parasympathetic functions baroreceptor reactivity and decrease in sympathetic response to stress.

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