

Publications

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**Impact of Short-Term Residential Yoga-Based Lifestyle Intervention on
Cognitive Function in Hypertensive Patients**

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Abstract

Background: Hypertension (HTN) is a highly prevalent disease and a leading cause of morbidity and mortality worldwide. It leads to several long term complications including cognitive impairment. Yoga is a form of alternative and complementary therapy known to be effective in improving cognitive function. There is however, a lack evidence of the role of yoga on cognitive function in hypertensive patients.

Aim: To study the impact of short term residential yoga-based lifestyle intervention on cognitive functions in hypertensive patients.

Methodology: Sixty hypertensive subjects, within age range 30 to 60 years (Mean \pm SD; 46.92 \pm 9.2 yrs) were enrolled in this study. Thirty subjects (IAYT) followed 6 days of residential yoga program, consisting of 5 hrs of different yoga sessions including physical practices, meditation, devotional songs, a low salt & calorie diet and counseling sessions at SVYASA University campus in Bengaluru. Thirty subjects (Non-IAYT) followed their daily routines. Subjects with diabetes, psychiatric problem, stroke, head injury, neuro-deficits, history of recent surgery, and previous exposure to yoga in last one year were excluded from the study. All the subjects were administered Digit Letter Substitution Test and Digit Forward and Backward Test at the baseline and after 6 days.

Results: For the IAYT group, there was a significant improvement in Digit Forward and Backward Test ($p > 0.001$) scores and in DLST test ($p > 0.001$) after 6 days of intervention compared to baseline. Whereas, non-IAYT group showed, no significant improvement in any of the variables assessed. Therefore, compared to the Non-IAYT group, the IAYT group showed significantly better improve in DF ($p < 0.001$), DB ($p < 0.001$) and DLST scores ($p < 0.001$).

Conclusion: Short term residential yoga practice helps in enhancing cognitive function in hypertensive patients.

Introduction

Hypertension (HTN) is one among the most common public health problems across the world. It is a leading cause of morbidity and mortality in both developing and developed countries. It accounts for about 13% of all global deaths/year [1].

HTN affects approximately 25% of the world population with an estimated increase of 60% cases by 2025 [2]. Furthermore, HTN is an independent and modifiable risk factor of cardiac disease, chronic kidney disease, Alzheimer's disease and stroke [3, 4]. The brain is a major target organ affected by hypertension.

Long term hypertension leads to damage of cerebral blood vessels and contributes to the narrowing of lumens of arteries and arterioles that nourish deep tissues in the brain. This process accelerates the development of atherosclerotic plaques in the cerebral blood vessels contributing to cognitive decline [5, 6, 7].

Many cross-sectional and longitudinal studies have confirmed the strong association of hypertension with cognitive decline [8]. Studies have also reported that HTN increases the risk of onset of dementia in elderly [9]. Midlife hypertension is known to be responsible for poor cognition and increased risk of development of dementia in later age of life [10]. Alzheimer's disease and vascular cognitive impairment are the two most common causes of cognitive [11]. Optimal blood pressure control is known to reduce the risk of Alzheimer's disease and generalized neurodegenerative changes responsible for cognitive impairment [12]. Yoga is an ancient system of mind-body medicine dedicated to bring balance to physical, mental, and emotional health of individual. Yoga prescribed by ancient Indian sages includes positive

mental attitude, compassionate behavior, a simple and healthy diet along with physical postures (asanas), breathing practices (pranayama), and meditation [13].

Several scientific investigations shown that practice of yoga postures, breathing techniques, meditation and relaxation techniques have positive influence on cardiac parameters and cognitive function [15, 16]. Evidences suggests that practice of yoga helps in reducing systolic and diastolic blood pressure, cardiac risk factors and improves general well-being in hypertension individuals [17]. It has been demonstrated that any injury to the brain tissue attracts the neural stem/progenitor cells towards injured area and activates the process of neurogenesis [18]. Oxidative stress is strongly associated with several neurodegenerative conditions such as Alzheimer's disease, dementia, Parkinson's disease. Oxidative stress is considered to be one of the most important causes of neurodegeneration and it has been demonstrated that increased oxidative stress is associated with decreased neural cell proliferation [19]. Several scientific investigations have demonstrated that practice of yoga the oxidative stress and degeneration process Stem cell implantation is also an emerging therapy in the medical field. This has been used in a variety of clinical conditions including neurodegenerative conditions such as Alzheimer's disease, Parkinson's disease, and cardiovascular diseases. In an animal experimental study it was demonstrated that stem cell implantation in infarcted areas of the brain improved cognitive abilities after such an implantation treatment [21]

Methodology

Subjects (Table 1)

Sixty hypertensive individuals within age range 30 to 60 years (with mean \pm SD; 46.92 ± 9.2 yrs) were divided into 2 groups; i.e. IAYT (30, 5 females) and non-IAYT group (30, 7

females). No significant difference was observed between the groups in terms of gender distribution and age (Table 1).

Inclusion and Exclusion Criteria

We included the subjects; hypertensive subjects within age range 30-60 years; of any gender willing to participate in the study.

Subjects were excluded if they had psychiatric problem; history of epilepsy; diabetes mellitus; resistance hypertension; head injury; neuro-deficits; history of recent surgery; previous exposure to yoga in last one year and secondary hypertension.

Ethical Considerations

Study was approved by Institutional Ethical Committee (IEC) of SVYASA Yoga University, Bangalore, India. Written informed consent was obtained from all the subjects before the commencement of the study.

Assessments

Cognitive Measures

Memory

Short term and working memory were assessed before and after intervention using digit forward and digit backward span of Wechsler's memory scale

The forward/backward digit span (Wechsler Adult Intelligence Scale-Revised (WAIS-R) (Wechsler, 1981)'REF' was used to measure immediate memory span. The dependent measures are total forward digit span and total backward digit span. In the forward digit span,

subjects can correctly repeat back a span of up to 16 digits. In the backward version, subjects recite a span of up to 14 digits backwards. Higher scores are indicative of higher memory recall [22].

Attention, Concentration and Processing Speed Were Assessed Using Digit Letter

Substitution Test (DLST)

DLST: It is one of the most widely used paper pencil test consists of 8 rows \times 12 columns of randomly arrayed digits. The key at the top of each sheet, pairs each of the 9 digits with 9 selected letters. Subjects have to write the corresponding letters in the empty box below each digit. Choice of strategy for substituting letters is up to each subject: horizontally, vertically, or selecting one digit at a time. Subjects have to substitute as many letters for digits as possible in the test time of 90 sec. Test supervisors timed each test on a standard stopwatch [23].

Blood Pressure

Heart rate, systolic blood pressure and diastolic blood pressure were assessed using FinaPres, NIBP system.

Intervention (Table 2)

IAYT Intervention

Subjects in IAYT group underwent a specialized 6 day residential yoga-based lifestyle intervention program at SVYASA university campus in Bangalore. Their daily programs included 3 hrs of specific yoga practices designed for hypertension, 2 sessions of volunteer regulation of breath (*Pranayama*), one meditation session and two sessions of relaxations and devotional songs, a low salt and low calorie diet along with counseling sessions. In

contrast, the control Non-IAYT group followed the typical (non-specialized) daily routines.

All the subjects were on anti-hypertensive medication [24].

Data Extraction and Analysis

Data extraction of digit forward, backward test and Digit Letter Substitution test was done followed the instruction given in the manual of Digit Forward Backward Test.

Table 2. Shows daily activates of subjects in IAYT group during intervention

Daily activities	Time (Hrs)	Daily activities	Time (Hrs)
Cyclic meditation	15:00	Ablution	5:00
HTN Special techniques	16:00	Om Meditation	5:30
Tuning to nature	17:00	HTN Special technique	6:00
Devotional session	18:00	Spiritual discourse	7:15
MSRT	18:45	Breast fast	8:00
Dinner	19:30	Yogic counseling	9:30
Happy assembly	20:30	Pranyama (Breathing techniques)	10:30
Group discussion/Self-study	21:15	Milk or herbal tea	11:30
Lights off	22:00	HTN Special technique	12:05
		Lunch & rest	13:00

HTN Special techniques: Includes special yoga practices designed for hypertension; Om Meditation: A Meditative technique; MSRT-Mind Sound Resonance Technique: It is a kind of yoga-based relaxation techniques includes chanting of mantra in supine posture; Happy Assembly- Playing indoor games, laughter, singing etc.

Table 14: Changes in Digit memory test and DLST before and after one week in IAYT group and non-IAYT group and IAYT Vs Non-IAYT group

Variables	IAYT group				Non-IAYT group				Between group
	Pre Mean± SD	Post Mean± SD	% change	P value	Pre Mean ± SD	Post Mean ± SD	% change	P value	P value
DF Span	4.30±1.23	6.60±1.35	53.49	<0.001	4.67±1.27	4.83±1.18	3.43	.902	<0.001**
DB Span	3.73±1.01	5.60±1.35	50.13	<0.001	3.93±1.20	4.03±1.10	2.54	.889	<0.001**
DLST TL	39.52±11.70	42.52±12.53	7.59	0.005	3.93±1.20	4.03±1.10	-6.25	0.052	<0.001**
DLST WA	0.14±0.35	0.12±0.4	-14.29	.12	0.30±0.47	0.60±0.67	33.30	0.072	0.052
DLST NT	39.98±11.8	42.38±12.5	7.62	0.006	37.27±10.94	35.28±11.78	-7.08	0.03	<0.001**

DLST; Digit Letter Substitution test, DF; Digit Forward, DB; Digit Backward, SYS; Systolic BP, Dia; Diastolic BP, HR; Heart rate. * Statistical significance at 0.01 level, ** Statistical significance level at 0.001 level

Results (Table 3)

Group Comparisons

IAYT Group

Pre-post comparison showed a significant improvement in systolic ($p = 0.004$) and diastolic ($p = 0.006$) BP, digit forward ($p < 0.001$) and digit backward ($p < 0.001$) test, DLST total attempt ($p = 0.005$) and DLST net attempt ($p = 0.006$) after 6 days of the program as compared to the baseline.

Non-IAYT Group

No significant improvement found in non-IAYT group but there was a significant decrease in DLST net score ($p = 0.03$).

Between Group Comparison

Between group comparison showed a significant improvement in systolic BP ($p = 0.038$), digit forward ($p < 0.001$) and digit backward ($p < 0.001$) test, DLST total attempt ($p < 0.001$) and DLST net attempt ($p < 0.001$) in the IAYT group as compared to non-IAYT group.

Discussion

The present study was aimed to assess the impact 6 days residential yoga-based lifestyle intervention on cognitive function in hypertensive subjects. We observed a significant improvement from the baseline in DBF test score and DLST score after one week in intervention group as compared to control group. The present results thus suggest that short term residential yoga program is beneficial in improving cognitive function in hypertensive individuals.

Several previous studies have reported the significant improvement in cognitive function following yoga practice in different subject populations. Similarly in our study, we also

found significant improvement in cognitive function following 6 days residential yoga intervention [25].

Most of the previous studies performed to assess the impact of yoga on cognitive function were in school children, healthy adults, elderly people, and few were in different medical conditions such as diabetes, multiple sclerosis etc. To the best of our knowledge this is the first study to investigate the efficacy of yoga intervention on cognitive function in hypertensive population.

A study by Kyizom et al. (2010) assessed the impact of 45 days Hatha yoga intervention on working memory and attention. Significant improvement in working memory and attention was reported after 45 days compared to the baseline. This present study also support the results observed by Kyizom. Both these studies differ in term of frequency and duration of yoga intervention, assessment tools used and subjects enrolled in the study. Compared to our study, the previous study was of longer duration (45 days), frequency of yoga sessions were less (1 session/day) and subjects were diabetic patients; whereas in our study, subjects were hypertensive patients and duration of intervention was shorter (6 days) and frequency of session was more (6 session/day). Even though subjects enrolled in both the studies differ, diabetes mellitus and hypertension are associated with cognitive decline [26].

Another study by Velikonja et al. (2010) assessed impact of 10 weeks Hatha yoga intervention on attention in subjects with multiple sclerosis and found a significant improvement in attention (using D2 test) in post assessment compared to the baseline. Similarly in our study, we also found significant improvement in attention assessed (using DLST), but the subjects in our study were hypertensive patients whilst the previous study's subjects were patients of multiple sclerosis. Intervention period in the previous study was 10

weeks, one session/day, whereas in our study intervention shorter (6 days) and frequency of yoga sessions were more/day as compared to previous study [27].

A study by Bowden (2012) [28], reported a significant improvement in working memory assessed using 2 back tests, following 5 weeks of Iyengar intervention twice a week in healthy adults. The present study is in support of Bowden's findings, in the previous study (Bowden), duration of yoga intervention was longer (5 weeks) but the frequency of yoga session was less (2 days/week) and the subjects were healthy adults, whereas in our study, duration of yoga intervention was short (6 days) but the frequency of yoga sessions were more (4 sessions/day).

Mechanism

The exact mechanism of yoga in improving cognition is not known. The following possible reasons might have contributed in improving cognition in present study:

- 1) The intervention included various yoga postures and loosening practices. Increased physical activity is known to improve cognition [29] by enhancing neural plasticity of brain areas which are involved in cognition [30, 31].
- 2) Stress is known to have negative effects on cognition [32] and yoga intervention is known to alleviate the stress and its effects [33]. Reduced stress is associated with improved cognition [34].
- 3) Various yoga postures needs constant attention and body awareness, practice of postures improves the ability of concentration and attention [35].
- 4) Different components of yoga such as meditation known to enhance neuro-plasticity of brain area which are associated with attention, concentration, sensory processing and memory [36].

Other reasons for improvement of memory in hypertensive subjects might be earnest sensitivity and acceptance to such interventions coupled with the intervention environment. A serene atmosphere free from daily possible psychological triggers, which are known to affect cognition, is a confounding variable. Short duration can also motivate commitment to the lifestyle modifications.

Strengths of Study

To the best of our knowledge, this is the first study to assess the impact of yoga on cognitive function in hypertensive patients. The intervention which included physical activity, breathing practices and diet modification adopted was a feasible and comprehensive lifestyle

for hypertension. The study includes the domains of medicine, Yoga, and neuropsychiatry field.

Limitation of the Study

Small sample size and non-RCT study; IAYT intervention given may be not practical to implement along with daily routines. Further, environments of both groups were different. More measuring tools could be incorporated as only paper pencil tests were used to assess primary outcome.

Future Suggestions

Future studies should be carried out using robust study design with larger sample size. Control group should be provided similar environment as that of intervention group. Introduction of latest and different computer-based cognitive tools could be used.

Acknowledgment

We are grateful to all the hypertensive patients who participated in this study.

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Aim: To study the impact of short term residential yoga-based lifestyle intervention on cognitive functions in hypertensive patients.

Methodology: Sixty hypertensive subjects, within age range 30 to 60 years (Mean \pm SD; 46.92 \pm 9.2 yrs) were enrolled in this study. Thirty subjects (IAYT) followed 6 days of residential yoga program, consisting of 5 hrs of different yoga sessions including physical practices, meditation, devotional songs, a low salt & calorie diet and counseling sessions at SVYASA University campus in Bengaluru. Thirty subjects (Non-IAYT) followed their daily routines. Subjects with diabetes, psychiatric problem, stroke, head injury, neuro-deficits, history of recent surgery, and previous exposure to yoga in last one year were excluded from the study. All the subjects were administered Digit Letter Substitution Test and Digit Forward and Backward Test at the baseline and after 6 days.

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Conclusion: Short term residential yoga practice helps in enhancing cognitive function in hypertensive patients.

Introduction

Hypertension (HTN) is one among the most common public health problems across the world. It is a leading cause of morbidity and mortality in both developing and developed countries. It accounts for about 13% of all global deaths/year [1].

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Subjects were excluded if they had psychiatric problem; history of epilepsy; diabetes mellitus; resistance hypertension; head injury; neuro-deficits; history of recent surgery; previous exposure to yoga in last one year and secondary hypertension.

Table 10: Baseline characteristics of the groups

Variables	IAYT	Non-IAYT	P value ^a
No of subjects	N=20; F=5 , M=15	N=20; F=7 , M=13	NS
Age(Mean) years	46.62±9.9	47.08±9.69	0.13
HR (bpm)	78.21±12.21	76.64±13.21	0.45
SBP (mmHg)	135.23±11.37	130.72±11.32	0.08
DBP (mmHg)	77.38±9.56	74.14±9.91	0.09
BRS 9ms/mmHg	6.30±1.63	6.43±1.60	0.13
TPVR	1427.24±166	1495.73±156.81	0.15
DLST Score	39.52±11.70	38.27±11.02	0.479
DF Score	4.30±1.23	4.67±1.27	0.113
DB score	3.73±1.01	3.93±1.20	0.433
BMI (kg/M ²)	25.45±5.86	26.27±4.15	0.13

HR-Heart rate, SBP-Systolic Blood pressure, DBP-Diastolic blood pressure, BRS-Baroreflex sensitivity, TPVR- Total peripheral vascular resistance, DLST-Digit Letter Substitution test, DF-Digit forward, DB-Digit backward, BMI-Body Mass Index. ^ap values after Independent sample t test.

Ethical Considerations

Study was approved by Institutional Ethical Committee (IEC) of SVYASA Yoga University, Bangalore, India.

Written informed consent was obtained from all the subjects before the commencement of the study.

Assessments

Cognitive Measures

Memory

Short term and working memory were assessed before and after intervention using digit forward and digit backward span of Wechsler's memory scale

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Blood Pressure

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Intervention (Table 2)

IAYT Intervention

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Data Extraction and Analysis

Data extraction of digit forward, backward test and Digit Letter Substitution test was done followed the instruction given in the manual of Digit Forward Backward Test.

Table 2. Shows daily activates of subjects in IAYT group during intervention

Daily activities	Time (Hrs)	Daily activities	Time (Hrs)
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HTN Special techniques: Includes special yoga practices designed for hypertension; Om Meditation: A Meditative technique; MSRT-Mind Sound Resonance Technique: It is a kind of yoga-based relaxation techniques includes chanting of mantra in supine posture; Happy Assembly- Playing indoor games, laughter, singing etc.

Table 14: Changes in Digit memory test and DLST before and after one week in IAYT group and non-IAYT group and IAYT Vs Non-IAYT group

Variables	IAYT group				Non-IAYT group				Between group
	Pre Mean± SD	Post Mean± SD	% change	P value	Pre Mean ± SD	Post Mean ± SD	% change	P value	P value
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DLST; Digit Letter Substitution test, DF; Digit Forward, DB; Digit Backward, SYS; Systolic BP, Dia; Diastolic BP, HR; Heart rate, * Statistical significance at 0.01 level, ** Statistical significance level at 0.001 level

Results (Table 3)

Group Comparisons

IAYT Group

Pre-post comparison showed a significant improvement in systolic ($p = 0.004$) and diastolic ($p = 0.006$) BP, digit forward ($p < 0.001$) and digit backward ($p < 0.001$) test, DLST total attempt ($p = 0.005$) and DLST net attempt ($p = 0.006$) after 6 days of the program as compared to the baseline.

Non-IAYT Group

No significant improvement found in non-IAYT group but there was a significant decrease in DLST net score ($p = 0.03$).

Between Group Comparison

Between group comparison showed a significant improvement in systolic BP ($p = 0.038$), digit forward ($p < 0.001$) and digit backward ($p < 0.001$) test, DLST total attempt ($p < 0.001$) and DLST net attempt ($p < 0.001$) in the IAYT group as compared to non-IAYT group.

Discussion

The present study was aimed to assess the impact 6 days residential yoga-based lifestyle intervention on cognitive function in hypertensive subjects.

We observed a significant improvement from the baseline in DBF test score and DLST score after one week in intervention group as compared to control group.

The present results thus suggest that short term residential yoga program is beneficial in improving cognitive function in hypertensive individuals.

Several previous studies have reported the significant improvement in cognitive function following yoga practice in different subject populations. Similarly in our study, we also found significant improvement in cognitive function following 6 days residential yoga intervention [25].

Most of the previous studies performed to assess the impact of yoga on cognitive function were in school children, healthy adults, elderly people, and few were in different medical conditions such as diabetes, multiple sclerosis etc. To the best of our knowledge this is the first study to investigate the efficacy of yoga intervention on cognitive function in hypertensive population.

A study by Kyizom et al. (2010) assessed the impact of 45 days Hatha yoga intervention on working memory and attention. Significant improvement in working memory and attention was reported after 45 days compared to the baseline. This present study also support the results observed by Kyizom. Both these studies differ in term of frequency and duration of yoga intervention, assessment tools used and subjects enrolled in the study. Compared to our study, the previous study was of longer duration (45 days), frequency of yoga sessions were less (1 session/day) and subjects were diabetic patients; whereas in our study, subjects were hypertensive patients and duration of intervention was shorter (6 days) and frequency of session was more (6 session/day). Even though subjects enrolled in both the studies differ, diabetes mellitus and hypertension are associated with cognitive decline [26].

Another study by Velikonja et al. (2010) assessed impact of 10 weeks Hatha yoga intervention on attention in subjects with multiple sclerosis and found a significant improvement in attention (using D2 test) in post assessment compared to the baseline. Similarly in our study, we also found significant improvement in attention assessed (using DLST), but the subjects in our study were hypertensive patients whilst the previous study's

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Mechanism

The exact mechanism of yoga in improving cognition is not known. The following possible reasons might have contributed in improving cognition in present study:

- 5) The intervention included various yoga postures and loosening practices. Increased physical activity is known to improve cognition [29] by enhancing neural plasticity of brain areas which are involved in cognition [30, 31].
- 6) Stress is known to have negative effects on cognition [32] and yoga intervention is known to alleviate the stress and its effects [33]. Reduced stress is associated with improved cognition [34].
- 7) Various yoga postures needs constant attention and body awareness, practice of postures improves the ability of concentration and attention [35].
- 8) Different components of yoga such as meditation known to enhance neuro-plasticity of brain area which are associated with attention, concentration, sensory processing and memory [36].

Other reasons for improvement of memory in hypertensive subjects might be earnest sensitivity and acceptance to such interventions coupled with the intervention environment. A serene atmosphere free from daily possible psychological triggers, which are known to affect cognition, is a confounding variable. Short duration can also motivate commitment to the lifestyle modifications.

Strengths of Study

To the best of our knowledge, this is the first study to assess the impact of yoga on cognitive function in hypertensive patients. The intervention which included physical activity, breathing practices and diet modification adopted was a feasible and comprehensive lifestyle for hypertension. The study includes the domains of medicine, Yoga, and neuropsychiatry field.

Limitation of the Study

Small sample size and non-RCT study; IAYT intervention given may be not practical to implement along with daily routines. Further, environments of both groups were different. More measuring tools could be incorporated as only paper pencil tests were used to assess primary outcome.

Future Suggestions

Future studies should be carried out using robust study design with larger sample size. Control group should be provided similar environment as that of intervention group. Introduction of latest and different computer-based cognitive tools could be used.

Acknowledgment

We are grateful to all the hypertensive patients who participated in this study.

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Effects of Integrated Approach of Yoga Therapy (IAYT) on Cardiac Variables and Mental Health in Hypertensive Patients with Elevated Anxiety and Depression

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Abstract

Background: Hypertension significantly affects the mental health of the patient. Elevated anxiety and depression are commonly observed in hypertensive subjects compared to normotensives. Previous studies have demonstrated the positive impact of IAYT on mental health in many chronic health problems.

Objectives: To study the effects of Integrated Approach of Yoga Therapy (IAYT) on anxiety and depression of hypertensive subjects with elevated anxiety and depression.

Methodology: We screened 131 hypertensive patients within age range 40-60 years for anxiety and depression (using Hospital Anxiety Depression Scale (HADS) HADS-A Score >11 or HADS-D Score >11), 92 subjects found to have either elevated anxiety or depression or both. These potential subjects underwent one week residential yoga program at Holistic Health care centre, S-VYASA University, Bangalore-India. Subjects under antipsychotic medication, had recent surgery, previous exposure to any form of yoga in past one year, secondary hypertension, resistant hypertension were excluded from the study. Heart rate, systolic & diastolic blood pressure, anxiety, and depression were assessed at baseline and after one week of IAYT intervention. Data was analyzed using SPSS version 10.

Result: At the baseline, of 92 potential subjects, 47 (51.08%) had clinical anxiety, 26 (28.26%) had clinical depression, and 19

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had both (20.65%). After one week of IAYT intervention significant decrease in pulse rate ($p < 0.001$), systolic ($p < 0.001$), & diastolic blood pressure ($p < 0.001$), anxiety ($p < 0.001$), and depression ($p < 0.001$) was observed compared to baseline.

Conclusion: Present study indicates the potential role of IAYT in improving mental health & cardiac variables in hypertension subjects. However, further randomized control trial should be performed to confirm the findings of the present study, which will be implemented in future studies.

Keywords: Hypertension, Anxiety, Depression, Yoga, IAYT

8.4 Introduction

Hypertension (HTN) is a major public health concern and a leading cause of morbidity and mortality across the globe [1]. HTN contributes to 13% of annual death/year (Dolhaf). It affect 25% of world population and it is estimated that, by the year 2025, 60% of world population will develop HTN [2]. HTN contributes to approximately 13% of yearly deaths worldwide [3, 4]. HTN is directly responsible for, 25% of deaths due to myocardial infarction, and 53% of death due to stroke. In a long run hypertension leads to several complications such as ischemic heart disease, stroke, glaucoma etc. [5]. Evidences from mind-body interaction studies showed a strong influence of mind on body physiology and vice-versa.

Studies demonstrated that emotions like, anger, anxiety, prolonged sadness (depression) have negative impact on heart

rate, blood pressure, heart rate variability, basal metabolic rate etc. [6, 7, 8, 9]. Long term exposure to such emotions contributes the cause of many chronic ailments like, coronary artery disease, accelerated aging process, diabetes, hypertension, migraine etc. [10, 11]. Among these psychological factors anxiety and depression are most predominantly found in several chronic health conditions including hypertension. Depression and anxiety are involved in development, maintenance and complication of the hypertension [12]. Hypertensive people known to have elevated anxiety [13] and depression level compared to age and gender matched healthy subjects. Elevated anxiety in hypertension increases the progression of atherosclerosis [14]. Increased anxiety level in patients with coronary intervention increase the risk of re-vascular intervention [15]. In an observational study pre-pregnancy existence of anxiety and depression is associated with pregnancy induced hypertension [16].

Depression is associated with increased risk of hypertension [17]. A survey report showed that 44% of individuals with depression at baseline were found to have developed hypertension [18]. In a cross-sectional study hypertensive subjects showed a higher chances of developing depression compared to normotensives [19]. Depression leads to many behavioral changes such as smoking, alcohol, reduced physical activity etc. which are associated with increased risk of hypertension and CVD [20, 21, 22, 23].

Some studies showed the evidence for brain stem cells dysfunction in the pathology of mental ailments including depression. A strong association of brain stems cell dysfunction in depression is prominently reported in many studies. Hippocampus is a major part of the brain believed to be involved in the pathogenesis of depression. Persons with depressive disorder are known to have reduced hippocampus thickness [24]. The cause of hippocampus atrophy in depression is believed to be reduced adult neurogenesis that decreases production of functional neuronal cells in the hippocampus area of the brain. Some post-mortem studies of depression patients showed an increased neuronal apoptosis suggestive of decreased neuronal stem cell functioning in depression. Structural and functional neuronal cells in hippocampus area are produced by neuronal stems cells present in subventricular zone [25]. Hence it thought that reduced hippocampus thickness is could be due to hypo-functioning of neuronal stems cell [26].

The anti-depressant interventions such as exercise [27], electroconvulsive therapy and some anti-depressant medications found to increase adult neurogenesis [28].

8.5 Yoga

The science of yoga was developed, practiced and proposed by ancient sages of Asian continent. Practice of yoga promotes physical and mental health leads to spiritual growth of the individual. Currently yoga is used as complementary and integrative medicine in many chronic health conditions such as, diabetes type-2, hypertension, coronary artery disease, chronic low back

pain, Parkinson's disease, depression, schizophrenia, etc. [29, 30, 31] Various meta-analyses have confirmed the beneficial role of yoga in mental health. Practice of yoga is known to reduce anxiety [32] and depression [33].

A study by Rao et al. 2016 showed a significant improvement in psychological health of female teacher following one month of relaxation technique [34].

8.5.1 Integrated Approach of Yoga Therapy (IAYT)

IAYT at SVYASA University campus is a residential program consists of yoga based lifestyle modifications. This program includes yoga sessions specially designed for hypertension twice daily, *pranayama* (yogic breathing practices), meditation devotional session and yogic cleansing techniques twice in a week. This program also includes diet modification based on the health problem. The whole program is conducted in residential set up [35]. Previously scientific investigations on IAYT have shown beneficial effects in several health conditions [36, 67]. A study by Rao J et al. 2017 showed a significant improvement in constipation related symptoms following one week of IAYT. Another study by Padmini T et al. 2012 showed a significant improvement in anxiety and quality of in subjects with chronic low back pain.

8.6 Need for the Study

Previously, several cross-sectional and longitudinal studies have demonstrated that the psychological domains including

anxiety and depression being contributing in factors cause of hypertension and complication of hypertension. Conventional medicine has limited role prevention and alleviation of anxiety and depression, anti-hypertensive medication does not reduce the anxiety and depression in hypertensive participants. Hence there is need of alternative intervention to control. Yoga is a non-pharmacological and cost effective intervention without side effects. Several studies have confirmed the positive role of yoga in reducing anxiety and depression. IAYT is a residential yoga based lifestyle intervention, conducted in SVYASA University. It is a comprehensive approach to deal modern non-communicable diseases. It includes yoga based diet, physical activity, stress management through, asanas, pranayama, meditation and devotional sessions. Several scientific investigation have show the positive role of yoga in many health related conditions including diabetes [38], constipation [39], anxiety [40], hypertension [41] etc.

8.6.1 Methodology

8.6.1.1 Subjects

Hypertensive subjects within age range 40-60 years who visited to Arogyadhama, S-VYASA University, Bangalore for one week IAYT program for hypertension between January 2016 to June 2016, were considered for the study.

8.6.1.2 Inclusion Criteria

We included the Hypertensive subjects within age range 40 to 60 years, both gender, willing to participate the study, HADS-A Score>11 or HADS-D Score>11

or both on only one antihypertensive medicine.

8.6.1.3 Exclusion Criteria

Subjects were excluded if they had: diabetes mellitus; resistant hypertension; secondary hypertension; taking antipsychotic medication; recent hospitalization for major health problem; pregnancy; previous exposure to any form of yoga in last one year; recent surgery and pregnant women were excluded from the study.

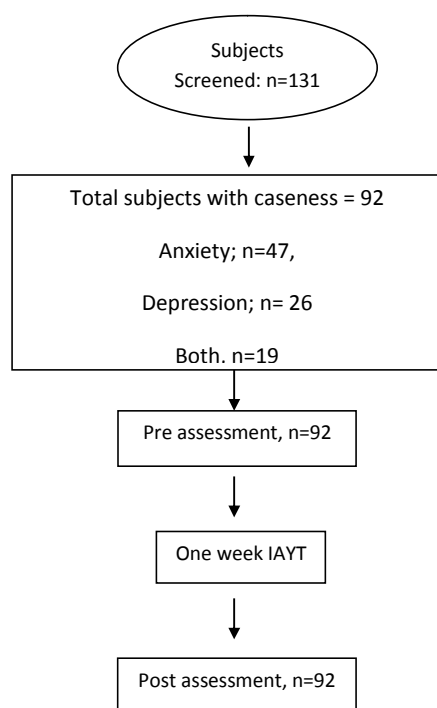
8.6.2 Procedure

We screened 131 subjects for clinical anxiety and depression, using Hospital Anxiety Depression Scale (HADS) for clinical anxiety and depression (using Hospital Anxiety Depression Scale (HADS) HADS-A Score>11 or HADS-D Score>11). Of 131 screened 92 participants found to have clinical caseness for anxiety and depression. Among 92 (70%), 47 found to have anxiety, 26 had depression and 19 had both.

8.6.3 Ethical consideration

All the subjects enrolled in the study we explained the study protocol in their respective language and a duly signed written informed consent was obtained from each subjects before commencement of the study.

Study was evaluated and approved by Institutional Ethical Committee (IEC) of SVYASA University.



hypertension, three times a day consisting of physical practices, breathing practices, and relaxation techniques along with weekly twice different types of yogic cleansing techniques, daily ½ hr devotional session, counseling sessions and tuning to nature [Detailed in Table 5 & 6].

8.6.7 Data Analysis

Descriptive data was showed in terms of mean and standard deviation. Data was found to be normally distributed by the Shapiro-Wilk test. Data prepost changes were assessed using paired sample t test. SPSS version 10.

8.6.4 Assessments

8.6.4.1 Cardiac Variables

Heart rate, systolic and diastolic blood pressure were assessed using Omran BP monitoring device at baseline and after one week.

8.6.4.2 Psychological Variables

Anxiety and depression were assessed using Hospital anxiety and depression scale (HADS)

8.6.5 Hospital Anxiety and Depression Scale (HADS)

It considered as one of the reliable and valid tools to assess subjective depression and anxiety in the past week. This scale includes 14 items (7 items for anxiety and 7 items for depression). Score equal or more 11 indicates clinical case [42].

8.6.6 Intervention

Subjects in yoga group underwent one week IAYT intervention consisting of yogic three session, one each, specific yoga sessions for

Table 6. List of Yoga practices in Yoga sessions

Type of practices	
Loosening practices (Sukshma vyayama)	Finger loosening, wrist loosening, elbow loosening, neck bending and rotation Twisting, hip rotation
Breathing practices	Hands in & out breathing, hands stretch breathing, ankle stretch breathing, tiger breathing
Asanas (physical postures)	Tadasana, vrikshasana, ardhachakrasana, ardhakati chakrasana, trikonasana Bhujangasana, ardhastrasana, badhakonasana, setibandhasana, bhujangasana, shalabhasana
Relaxation techniques	Quick relaxation technique, deep relaxation technique, mind sound resonance technique, Cyclic meditation
Pranayama	Chandra anuloma vilom, nadishudhi pranayama, bhramari pranayama, sheetali pranayamas

Time	Activity	Time	Activity
05:00 AM	Abution	03:00 PM	Cyclic meditation
05:30 AM	Prayer (Prathasman)	04:00 PM	Asana / Special yoga technique
06:00 AM	Asana / Special yoga technique	05:00 PM	Tuning to nature
07:15 AM	Friendship meet (Maitri -milan)- Gita sloka chanting and discourse (Satsang)	06:00 PM	Devotional session (Bhajan)
08:00 AM	Breakfast	06:45 PM	M/SRT (Mind sound resonance technique)
09:30 AM	Yogic Counseling	07:30 PM	Dinner
10:30 AM	Pranayama	08:30 PM	Happy assembly /yoga game session /cultural program
11:30 AM	Milk or ayurvedic tea (Malt)	09:15 PM	Group discussion/self practice
12:05 PM	Special yoga techniques	10:00 PM	Lights off
01:00 PM	Lunch and rest		

8.7 Results

8.7.1 Demographics

We screened 131 (68 males) of which 92 (70.21%) among 92 potential subjects, 47 (51.08%) had clinical anxiety, 26 (28.26%), had clinical depression, and 19 (20.65%) had anxiety and depression both (See Table 1). No significant change was found in mean age of both gender.

Table 1. Demographics

Variables	Male (n=68)	Female (n=63)	Total (131)
Age (mean \pm SD)	53.45 \pm 11.54	55.61 \pm 10.91	54.99 \pm 11.30
Clinical anxiety	24	23	47 (51.08%)
Clinical depression	9	17	26 (28.26%)
Both	12	7	19 (20.65 %)

Table 1 shows the gender-wise age, number of subjects with clinical anxiety, depression and both. Average age of the subjects is 54.99. Among 131 subjects 92 subjects had found clinical caseness and Majority of the subjects had clinical anxiety (51) compared to depression.

8.7.2 Correlation

We found a significant positive correlation between anxiety and depression ($p < 0.001$, Pearson's Corr. = 0.501).

8.7.3 Pre-Post Comparison

8.7.3.1 Subjects with Clinical Anxiety

We found a significant decrease in pulse rate ($p < 0.001$, -15.09%), systolic blood pressure ($p < 0.001$, -12.40%) and diastolic blood pressure ($p < 0.001$, -17.14%) along HADS A ($p < 0.001$, -54.98%) scores after one week IAYT intervention in subjects who had subjects clinical anxiety (Table 2).

Table 2. Pre-post changes in all the variables in patients with clinical anxiety

Variables	Pre [Mean±SD]	Post [Mean±SD]	% change	df	P value
Pulse (bpm)	82.40±9.97	69.96±7.36	-15.09	46	<0.001
Sys BP (mmHg)	144.68±11.76	126.73±7.22	-12.40	46	<0.001
Dia BP (mmHg)	93.48±9.75	77.45±5.19	-17.14	46	<0.001
Anxiety score	13.44±21.66	6.05±2.57	-54.98	46	<0.001

Table 2 shows the changes in blood pressure and anxiety scores following one week yoga intervention. Significant improvement is seen in all the variables. P value of 0.001 indicates the highly significant change Abbreviations: Sys BP-Systolic blood pressure, Dia BP-Diastolic blood pressure.

8.7.3.2 Subjects with Clinical Depression

There was significant decrease in pulse rate ($p < 0.001$, -22.08%), systolic blood pressure ($p < 0.001$, -17.62%) and diastolic blood pressure ($p < 0.001$, -17.18%) along with significant decrease in depression ($p < 0.001$, -52.21%) scores observed after one week IAYT intervention in subjects with clinical depression (Table 3).

Table 3. Pre-post changes in all the variables in patients with clinical depression

Variables	Pre [Mean±SD]	Post [Mean±SD]	% change	df	P value
Pulse (bpm)	87.65±7.33	68.30±7.63	-22.08	25	<0.001
Sys BP (mmHg)	152.65±6.73	125.76±4.73	-17.62	25	<0.001
Dia BP (mmHg)	94.87±7.38	78.57±4.81	-17.18	25	<0.001

Depression score	13.57±1.66	6.48± 2.65	-52.21	25	<0.001
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Table 2 shows the changes in blood pressure and depression scores following one week yoga intervention. Significant improvement is seen in all the variables. P value of 0.001 indicates the highly significant change. Abbreviations: Sys BP-Systolic blood pressure, Dia BP-Diastolic blood pressure.

8.7.3.3 Subjects with both Clinical Anxiety and Depression

There was significant decrease in pulse rate ($p < 0.001$, -18.58%), systolic blood pressure ($p < 0.001$, -17.68%) and diastolic blood pressure ($p < 0.001$, -19.61%) along with significant decrease in anxiety ($p < 0.001$, -46.16%) and depression ($p < 0.001$, -50.19%) scores observed after one week IAYT intervention in subjects with clinical depression (Table 4).

Table 4. Pre-post changes in all the variables in patients with clinical anxiety and depression both

Variables	Pre	Post	% change	df	P value
Pulse (bpm)	85.63±7.76	69.72±8.74	-18.58	18	<0.001
Sys BP (mmHg)	153.83±6.61	123.66± 5.65	-19.61	18	<0.001
Dia BP (mmHg)	95.62± 6.79	78.62±4.66	-17.78	18	<0.001
Anxiety score	13.82±2.92	7.44±31.82	-46.16	18	<0.001
Depression score	13.19±1.32	6.57±2.77	-50.19	18	<0.001

Table 2 shows the changes in blood pressure and anxiety & depression scores following one week yoga intervention. Significant improvement is seen in all the variables. P value of 0.001 indicates the highly significant change. Abbreviations: Sys BP-Systolic blood pressure, Dia BP-Diastolic blood pressure.

8.8 Discussion

This study intended to see the effects of one week of yoga based lifestyle intervention (IAYT) on cardiac and mental health in patients with elevated anxiety and depression. At the baseline among 92 potential subjects 47 (51.08%) participants had anxiety and 26 participants had clinical depression (28.26%) and 19 (20.65) had both anxiety and depression.

Though our study screened small sample of 131 subjects with hypertension we noticed a high prevalence of anxiety and depression (70%), which is consistent with previous studies [43].

After one week of IAYT intervention there was a significant decrease in anxiety, depression, systolic & diastolic blood pressure in subjects with either anxiety or depression or both.

We also observed a strong positive correlation between anxiety and depression. To the best of our knowledge this is the first to assess the impact of yoga intervention on mental health among hypertensive subjects.

IAYT is residential yoga based lifestyle intervention. Earlier studies of IAYT have confirmed its usefulness in several chronic diseases such as chronic low back pain [44]. osteoarthritis, [45] menopausal syndrome etc.

Previously few studies have looked into effectiveness of IAYT on mental health in chronic health disorders. Among these a study by Padmini T found a significant decrease in anxiety associated with chronic low back pain after one week of IAYT. Another study by John E found a significant reduction in depression after one week of IAYT in participants with osteoarthritis.

Anxiety and depression are the common mental health problems associated with several chronic health conditions including hypertension. IAYT intervention shows a promising role in improving mental health by reducing anxiety and depression in hypertension.

The exact mechanism IAYT in current study is not known. Possible mechanisms can could be, practice of various *asanas*, *pranayama*, meditation and devotional sessions in IAYT lead to down regulation of hypothalamo-pituitary-adrenal axis, causing parasympathetic dominance which lead to decrease in pulse, blood pressure and anxiety [46, 47]. Change in the

atmosphere, Interaction with therapist, group practice of yoga, and increased physical activity might have lead to decrease in depression.

Further, neural stem cell proliferation is involved in various brain functions including, learning, stress induced neuropathology, & affective disorders [48]. There are evidences suggesting the strong involvement of neuronal stem cell proliferation in pathology of depression [49]. Studies reported decreased neural proliferation in hippocampus in depressed patients. And some post-mortem studies on depressed patients showed an evidence of increased apoptosis in hippocampus. These findings indicate the neural stem cell involvement in pathology of depression.

There are studies demonstrated learning, enriched environment and exercise are some of the factors promote neural stem cells proliferation in hippocampus [50]. Similarly in our study the residential atmosphere at SVYASA where the study has been conducted is enriched and the lot of yoga sessions was comprised of adequate physical activity. Probably this might have lead to enhanced proliferation of neural stem cell in the hippocampus and improved mental health. However, future studies should attempt to explore the impact of yoga on neural stem cell proliferation in clinical population.

8.9 Conclusion

Present study indicates the potential role of IAYT in improving mental health & cardiac variables in hypertension subjects. However, further randomized control trial should be performed to confirm the findings of the present study, which will be implemented in future studies.

Strengths of this study are; 1) Good adherence rate 2) No adverse effects were observed during the intervention 3) It is first study to assess the effect of IAYT on psychological states

in hypertensive participants 5) IAYT is a comprehensive treatment modality which includes diet, physical activity, meditation, pranyama and counseling

Limitations: This study has got several limitations; 1) Lack of control group 2) Small sample size, 4) Short term intervention 5) Lack of follow up.

8.10 Future Suggestions

Future studies should include 1) Control group with Proper randomization 2) Control group should follow some international standard intervention 3) Objective variables like serum cortisol levels, heart rate variability etc. should also be assessed.

8.11 Conflict of Interest

The authors declare no conflict of interest.

8.12 Acknowledgment

We are thankful to all the therapist, doctors and staff of *Arogydhama* holistic health centre, S-VYASA. We thank to all the subjects who participated in this study.

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Title: Effect of one week Yoga based residential program on cardiovascular variables of hypertensive patients: A comparative study

Abstract

Introduction: Hypertension (HTN) is an important public health concern and a leading cause of morbidity and mortality all over the world. Yoga is a form of mind-body medicine shown to be effective in controlling blood pressure and reduces cardiac risk factors in HTN. Integrated Approach of Yoga Therapy (IAYT) is a residential yoga based lifestyle intervention proved to be beneficial in health conditions such as arthritis, chronic low back pain, diabetes etc.

Aim: To study the efficacy of one week of residential IAYT intervention on cardiovascular parameters in hypertensive patients.

Methods and materials: Twenty HTN subjects (7 females) within age range between 30-60 years (Average; 46.62 ± 9.9 years), who underwent one week of IAYT treatment for hypertension, were compared with age and gender-matched non-IAYT group (5 females; average age; 47.08 ± 9.69 years) in terms of systolic (SBP), diastolic (DBP) and mean arterial blood pressure (MAP), cardiac output (SV), stroke volume (CO), baroreflex sensitivity (BRS) and total peripheral vascular resistance (TPVR), at Arogyadhama-at SVYASA university campus. One week of residential IAYT program consisted of sessions of asanas, breathing practices, meditation and relaxation techniques, low salt, low-calorie diet, devotional session and counseling. Subjects in non-IAYT group followed their normal routine. Data was analyzed using SPSS version 16. RM-ANOVAS was used.

Results: A significant improvement in (p=0.004) and DBP (p=0.008), MAP (0.03), BRS (p<0.001) and (p=0.007) in IAYT, whereas in control group we did not find a significant difference in any of the variables. Between-group comparison showed significant improvement in SBP (p=0.038), BRS (p=0.034) and TPVR (p=0.015) in IAYT group as compared to Non-IAYT group.

Conclusion: One-week IAYT intervention showed improvement in baroreflex sensitivity, systolic blood pressure and total peripheral vascular resistance.

Keywords: Yoga, IAYT, Hypertension, baroreflex sensitivity, peripheral vascular resistance, Blood pressure

Introduction

Hypertension

Essential hypertension (HTN) is one of the most common public health problems and a leading cause of morbidity and mortality worldwide. It is a modifiable and an independent risk factor for stroke, cardiac disease, and chronic kidney disease

^{1 2} HTN is responsible for 57% deaths due to stroke and 24% deaths due to coronary artery disease.³

Evidences suggest the growing trends in HTN prevalence all over the world. In China prevalence of HTN reported to be 27%⁴. A survey conducted in 2003 in US, Europe and Canada reported 28% (lowest) prevalence of hypertension in US countries and 44% (highest) in European countries.⁵ In India highest prevalence of HTN in urban population is men 44%, women 45% found in Mumbai (survey report reported in years 1999) and lowest 14% in Chennai (survey report reported in years 2000).⁶

Cause of is believed to be the complex interaction between genetic and environmental factors. Environmental factor includes urban lifestyle characterized by sedentary job, psychological stress, junk food consisting of high calorie, salt and less fiber food.⁷

These causes contribute to autonomic imbalance, dominated with reduced vagal tone and increased sympathetic activity. As the lifestyle is a major cause of hypertension and lifestyle modification intervention plays a major role in management and cure of HTN.

Yoga

Yoga is a holistic science, discovered and developed by ancient Indian sages around 5000 years back. It is a tradition of lifestyle, health and spirituality.⁸ Yoga consists of several mind-body practices including physical postures, breathing techniques, and meditation. Several scientific investigations have demonstrated the health benefiting effects of yoga practice in healthy and diseased conditions. Yoga improves cardiovascular variables such as blood pressure, heart rate, heart rate variability, baroreflex sensitivity^{9,10} Practice of yoga shown to be effective in improving blood pressure control, heart rate, and heart rate variability in hypertensive individuals.¹¹ A comprehensive review by Innes et al, reported that yoga practice enhances the parasympathetic activity and reduces sympathetic tone by decreasing

activation of hypothalamo-pituitary-adrenal axis.¹² Damodar et al, demonstrated the potential role of yoga in improving cardiac risk factors.¹³

Integrated Approach of Yoga Therapy (IAYT)

IAYT is a residential yoga based lifestyle intervention program for various chronic health conditions, conducted by SVYASA University campus, Bengaluru. IAYT consists of several mind-body practices, which include repeated sessions of yoga practice, breathing practices and cleansing techniques (designed for specific health conditions), low salt and low calorie diet, devotional session and tuning to nature.

Previous scientific investigations on IAYT have demonstrated its beneficial in chronic low back pain,¹⁴ anxiety,¹⁵ osteoarthritis,¹⁶ constipation¹⁷ etc.

None of the earlier studies on IAYT have looked into its efficacy in hypertension.

With this background the present study was designed to study the impact of one week IAYT intervention on cardiovascular parameters in subjects with hypertension.

Methodology

Subjects:

Forty hypertensive subjects (20 IAYT and 20 Non-IAYT group) within the age range 30-60 years with history of minimum 5 years of hypertension were enrolled in this study.

IAYT group: Hypertensive subjects who visited SVYAS university campus to attend one week IAYT program for hypertension were included in IAYT group

We included 20 eligible hypertensive subjects (with age mean:SD;)

Non-IAYT group: We included 20 eligible hypertensive subjects (with age mean:SD;). Hypertensive subjects from local area nearby SVYASA campus who is on regular antihypertensive medication were included in Non-IAYT group and following their daily routine.

Inclusion criteria

Hypertensive subjects within age range 30-60 years

Not having previous exposure to any yoga in part 1 years

Willing to the study

Exclusion criteria

Subjects having diabetes mellitus

Any form psychiatric problem

Who had previous exposure to any form of yoga in the past one years.

Who had recent any kind of surgery

Hypothyroidism, cardiac arrhythmia were excluded from the study

Outcome variables

-) Heart rate
-) Systolic, diastolic and Mean Arterial blood pressure
-) Cardiac out put
-) Stroke volume
-) Total peripheral vascular resistance
-) Baroreflex sensitivity

Assessments

All the assessments were conducted using FinaPress non-invasive BP monitoring system before and after one week. Subjects were assessed in the morning around 11-12 PM, in a silent room, seated on a chair, in relaxed state.

FinaPress

Intervention

IAYT group:

Subjects in IAYT group underwent one week of residential IAYT intervention consisting of repeated sessions of asana, pranyama, relaxation techniques designed for hypertension (the module was being used since more than 20 years), subjects followed *satvika* diet consisted of low salt, low calorie and high fiber food and devotional sessions and counseling sessions.

Results

There were no significant differences between the groups in terms of age, gender distribution and BMI (Table 1).

Within group comparison (Table 2)

IAYT group

There was a significant decrease in systolic blood pressure ($p=0.004$), diastolic blood pressure ($p=0.008$), mean arterial pressure (0.03), baroreflex sensitivity ($p<0.001$) and total peripheral vascular resistance ($p=0.007$) after one week of IAYT capered to baseline, whereas in control group we did not find significant difference in any of the variables.

Between groups comparison showed a significantly better improvement systolic blood pressure ($p=0.038$), baroreflex sensitivity ($p=0.034$) and total peripheral vascular resistance ($p=0.015$) in IAYT group as compared to Non-IAYT group.

Table : Baseline characteristics of the groups

Variables	IAYT	Non-IAYT	P value
No of subjects	N=20; F=5 , M=15	N=20; F=7 , M=13	NS
Age (Mean) years	46.62±9.9	47.08±9.69	NS
BMI (kg/M ²)	25.45±5.86	26.27±4.15	NS

Table 11: Within group and between groups Prepost changes in IAYT & Non-IAYT groups

Parameters	IAYT group				Non-IAYT group				Between group comparison
	Pre (Mean±SD)	Post (Mean±SD)	% Change	P ¹ value	Pre (Mean±SD)	Post (Mean±SD)	% Change	P ¹ value	P ² value
Heart rate (bpm)	78.21±12.2 1	77.11±11.21	-1.41	0.665	76.64±13.21	75.51±12.79	-1.47	0.72	0.579
SBP (mmHg)	135.23±11.37	122.73±8.9	-9.24	.004	130.72±11.32	138.62±10.77	6.04	0.10	.041
DBP (mmHg)	77.38±9.56	71.45±6.537	-7.66	.008	74.14±9.91	76.16±8.95	2.72	0.32	0.095
Mean Arterial pressure (mmHg)	100.02±10.1	91.722±7.1	-8.30	0.003	96.060±10.21	94.60±9.2	-1.52	0.33	0.298
Cardiac output (ml/minute)	6.55±0.43	6.76±0.38	3.21	0.46	6.09±0.25	6.19±0.31	1.64	0.87	0.557
Stroke volume (ml/stroke)	84.95±5.74	85.98±4.67	1.21	0.826	80.61±3.39	83.88±4.88	4.06	0.48	0.785
Baroreflex sensitivity (ms/mmHg)	6.30±0.74	8.97±0.92	42.38	0.001	6.43±0.60	6.61±0.57	2.80	0.15	.001
Peripheral vascular resistance dyn·s/cm⁵	1427.24±16	1036.94±135	-27.35	.007	1495.73±156.81	1347.01±134.83	-9.94	0.60	.027

Discussion

This study was aimed to see the efficacy of one week of residential IAYT intervention on cardiovascular variables in hypertensive patients. We observed a significant improvement in systolic, diastolic blood and mean arterial pressure, baroreflex sensitivity and total peripheral vascular resistance in intervention as compared to Non-IAYT group.

IAYT is a residential yoga setup at SVYASA university campus. IAYT was designed by Dr Nagaratna R, Medical consultant with experience in yoga therapy. Previous studies on IAYT showed its potential role in management of various chronic health problems such as chronic low back pain, osteoarthritis, asthma, anxiety etc. This study is the first attempt to assess the efficacy of IAYT in hypertension.

Yoga intervention has shown to be effective in improving various cardiovascular parameters in healthy hypertensive, and cardiac conditions.

A systematic review by Marshal H, 2013, reported that yoga is an effective intervention in reducing blood pressure in hypertension.¹⁸ In our study, we also found significant improvement in blood pressure after one week of IAYT.

Very few studies have assessed efficacy of yoga on baroreflex sensitivity in hypertension. An immediate effect study showed a slow breathing at a rate of 6 breaths/minute showed improvement in baroreflex sensitivity immediately after practice.¹⁹

In another study by Bowmen A, 1997, 6 weeks of yoga intervention improved baroreflex sensitivity in elderly persons, whereas practice of aerobic exercises for same in similar population did not improve baroreflex sensitivity.²⁰ Similarly we also found significant improvement in baroreflex sensitivity but the duration of intervention was shorter in our study than previous study and previous studies were in healthy persons.

Another study by O Parshad, 2011, sixty-four healthy students of average age 21.3 years underwent six weeks of yoga practice (one session/week) post intervention a significant decrease in systolic and diastolic blood pressure, mean arterial blood pressure, cardiac output, stroke volume and total peripheral vascular resistance was observed.²¹

In our study we also observed significant reduction in total peripheral vascular resistance but we did not find improvement in cardiac output and stroke volume, the possible reason could

be that hypertension leads to left ventricular hypertrophy which significantly affects the stroke volume and cardiac output as well. One week of intervention may not be sufficient to bring an improvement in left ventricular hypertrophy due which there was no improvement in cardiac output and stroke volume. The intervention period was lesser in our study and the previous study was in healthy students. To the best of our knowledge none of the earlier studies have assessed the efficacy of yoga in improving total peripheral resistance in hypertension.

The exact mechanism behind these findings is not known. However, the possible mechanism could be change in the lifestyle in terms of reduced salt intake,²² increased physical activity,²³ reduces routine psychological stressors,²⁴ and repeated practice of relaxation and breathing practices.²⁵ All these components of residential IAYT lifestyle might have helped to reduce the blood pressure, total peripheral vascular resistance and improved baroreflex sensitivity via down-regulation of hypothalamo-pituitary adrenal axis, improvement in vagal activity and reduced sympathetic arousal.²⁶

Strengths of the study: 1) To the best of our knowledge it the first study to assess the effect of yoga on baroreflex sensitivity and total peripheral vascular resistance in patients with hypertension. 2) It is the first study to assess the effect of IAYT on cardiovascular parameters in hypertension, 3) No adverse effects were observed during the IAYT intervention suggesting feasibility of IAYT in hypertension, 4) As intervention was a residential setup adherence rate was 100%. 4) IAYT is a comprehensive yoga lifestyle.

Limitations of the study:

This several limitations such as 1) Lack of proper control group and randomization, 2) Small sample size, 3) Short intervention, 4) IAYT intervention is difficult follow with daily routine.

Suggestions for future studies:

Future studies should be carried out using randomized controlled design, 2) other cardiac autonomic functions such as heart rate variability, biochemical variables should be assessed. 3) Duration of the intervention should be larger and follow up should be done

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