

**Research Article****Effect of Sudarshan Kriya Yoga on Cardiovascular Parameters and Comorbid Anxiety in Patients of Hypertension****Pramod Kumar Narnolia<sup>1</sup>, Bijender Kumar Binawara<sup>1</sup>, Akhil Kapoor<sup>\*2</sup>, Mamata Mehra<sup>3</sup>, Manoj Gupta<sup>1</sup>, Khemlata Tilwani<sup>1</sup>, Sitaram Maharia<sup>2</sup>**<sup>1</sup>Department of Physiology, Sardar Patel Medical College and Hospitals, Bikaner, Rajasthan-334003, India<sup>2</sup>Department of Oncology, Sardar Patel Medical College and Hospitals, Bikaner, Rajasthan-334003, India<sup>3</sup>Department of Pathology, Sardar Patel Medical College and Hospitals, Bikaner, Rajasthan-334003, India**\*Corresponding author**

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**Abstract:** Sudarshan Kriya Yoga (SKY) is a special yogic package designed by Sri Sri Ravishankar, the founder of Art of Living foundation. In healthy individuals after 8 days of practicing SKY positive effect have been found on lipid profile and pulmonary functions, betterment of antioxidant status and anxiety have been also reported. SKY has a sound scientific basis and is an ideal tool for improving the health. However to put yoga on a firm pedestal and popularize it among public, we planned to undertake a study of the effect of SKY on cardiovascular health (SBP, DBP, PR, Lipid profile) and Hamilton anxiety score in patients of hypertension. In our study 100 patients of hypertension of either gender age group (30-70 years) at SP Medical College and PBM Hospital Bikaner were recruited. All the patients were on prescribed antihypertensive medications. They were divided randomly into study and control groups including 50 patients each. Study group was asked to do 'Sudarshan Kriya Yoga' one hour daily or at least five times a week for continuous three months after proper training. Statistically significant benefit of SKY was obtained in SBP, DBP, PR, Lipid profile and Hamilton anxiety score in patients of hypertension. Sudarshan kriya yoga showed statistically significant decrease in the values of all the above parameters after 3 months of practice.**Keywords:** Sudarshan kriya yoga, Hypertension, Cardiovascular health.

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**INTRODUCTION**

Sudarshan Kriya Yoga (SKY) is a special yogic package designed by Sri Sri Ravishankar, the founder of Art of Living foundation. SKY is based on rhythmic breathing exercise called Sudarshan Kriya (SK), Pranayam involving ujjayi breathing (breath touching the throat). Besides this it emphasizes importance of prayers, asanas, meditation, vegetative satvic (pure) diet and interactive discussions for attitude training based on 'Art of living knowledge points' [1]. Modern man is the victim of stress and stress related disorders which threaten to disrupt life totally [2].

Hypertension also called as silent killer is one of the most important public health problems worldwide. The overall prevalence of hypertension in India is 10% and 25% in rural and urban population respectively [3]. Yoga, an ancient Indian Science has been practiced as a healthy way of life. Recently yoga has been adopted as an approach to health within alternative medicine [4]. Yogic breathing is a unique method for balancing the autonomic nervous system and influencing psychologic and stress related disorders [5]. SKY has been shown promise in reducing systolic and diastolic blood

pressure. Moreover improvement in mental health was observed by decrease in Hamilton anxiety and Hamilton depression score significantly in healthy individuals [6].

In healthy individuals after 8 days of practicing SKY positive effect have been found on lipid profile and pulmonary functions [7] betterment of antioxidant status and anxiety have been also reported. SKY has a sound scientific basis and is an ideal tool for improving the health. However to put yoga on a firm pedestal and popularize it among public, we planned to undertake a study of the effect of SKY on cardiovascular health (SBP, DBP, PR, Lipid profile) and Hamilton anxiety score in patients of hypertension.

**MATERIALS AND METHODS**

In our study 100 patients of hypertension of either gender age group (30-70 years) at SP Medical College and PBM Hospital Bikaner were recruited. All the patients were on prescribed antihypertensive medications. They were divided randomly into study and control groups including 50 patients each. The study was conducted from August 2012 to December 2013. Study group was asked to do 'Sudarshan Kriya

Yoga' one hour daily or at least five times a week for continuous three months after proper training at The Art of Living centre Rani Bazar Bikaner by trained teachers. Before starting the intervention baseline parameters (i. e. BMI, WHR, SBP, DBP, HR, Serum Lipid profile and HAMA) were recorded for every patient. Same set of observations was repeated after 3 months of study period. All the subjects participated voluntarily in the study. Exclusion criteria were any major illness other than hypertension i.e. cancer, heart disease, arthritis, asthma, ulcer and pregnancy in women. An informed written consent was taken from

participants for tests performed and SKY training. The entire protocol was approved by the human ethics committee of SP Medical College, Bikaner.

**RESULTS**

Statistically significant benefit of SKY was obtained in SBP, DBP, PR, Lipid profile and Hamilton anxiety score in patients of hypertension.

Table 1 and 2 show the demographic profile of both groups.

**Table 1: Comparison between two groups according to their age and sex**

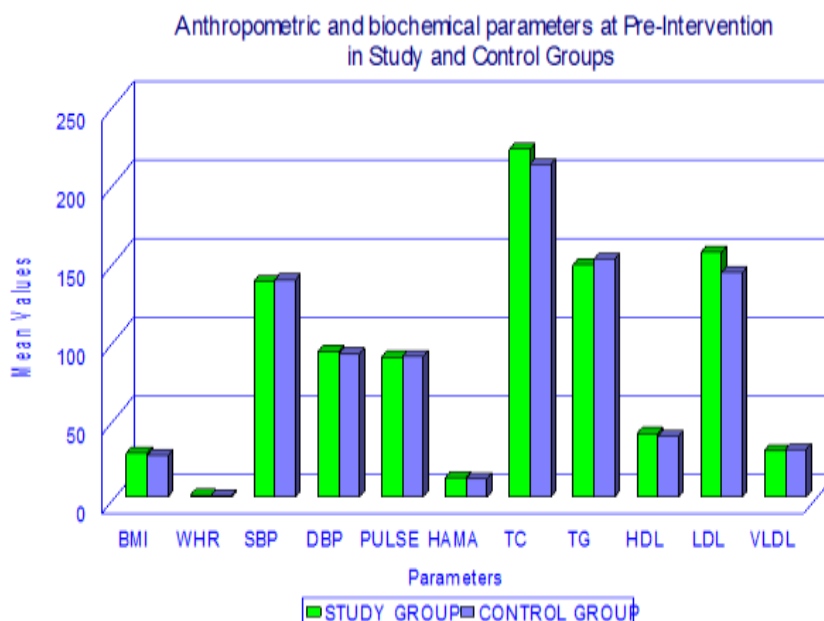
Age Group (years)	Sex											
	Control Group						Study Group					
	Female		Male		Total		Female		Male		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
≤40	1	2	1	2	2	4	0	-	4	8	4	8
41-50	11	22	5	10	16	32	8	16	16	32	24	48
51-60	7	14	14	28	21	42	5	10	7	14	12	24
>60	0	-	11	22	11	22	5	10	5	10	10	20
Total	19	38	31	62	50	100	18	36	32	64	50	100

**Table 2 : Mean age of subjects under study**

	Female		Male		Total	
	Control Group	Study Group	Control Group	Study Group	Control Group	Study Group
Mean	49.37	53.83	57.00	49.34	54.10	50.96
SD	5.41	9.53	7.26	8.21	7.55	8.88
SE	1.24	2.25	1.30	1.45	1.07	1.26
T	1.765		3.916		1.904	
P	0.086		<0.001		0.060	

**Table 3: Anthropometric and biochemical parameters at pre-intervention in study and control groups**

Parameters	Study Group		Control Group		t	p	
	Mean	SD	Mean	SD			
BMI (kg/m <sup>2</sup> )	27.90	3.65	26.36	4.03	1.999	0.048	
W/H Ratio	0.96	0.06	0.95	0.06	0.170	0.865	
Blood Pressure (mmHg)	Systolic	137.36	8.11	138.24	8.94	0.516	0.607
	Diastolic	92.48	6.24	91.12	7.51	0.985	0.327
Pulse/min	89.00	6.98	89.44	6.10	0.336	0.738	
HAMA	12.34	6.98	11.68	5.77	0.515	0.607	
Lipid Profile (mg/dl)	TC	221.26	38.02	211.72	38.29	1.250	0.214
	TG	147.64	28.78	151.24	41.30	0.506	0.614
	HDL	40.30	5.15	38.72	3.53	1.789	0.077
	LDL	155.63	43.90	142.75	37.32	1.581	0.117
	VLDL	29.52	5.76	30.25	8.26	0.506	0.614



**Fig. 1: Anthropometric and biochemical parameters at pre-intervention in study and control groups**

Baseline characteristics of the subjects in the study and control groups are given in table 3 before intervention. WHR, BMI, Systolic and diastolic blood pressure, pulse

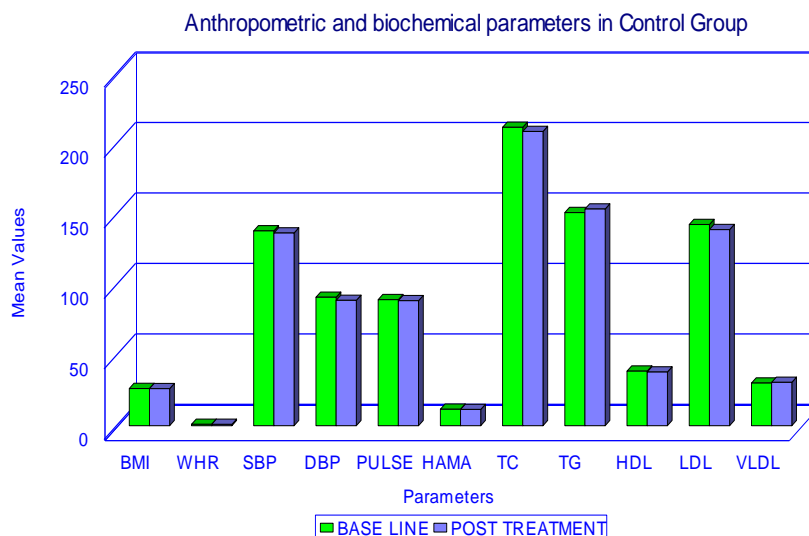
rate, lipid profile (TC, TG, HDL, LDL and VLDL) and HAMA are comparable between both the groups ( $p < 0.1$ ).

**Table 4: Anthropometric and biochemical parameters in Control Group**

Parameters	Base Line		Post Treatment		t	p	
	Mean	SD	Mean	SD			
BMI (kg/m <sup>2</sup> )	26.36	4.03	26.24	0.155	0.155	0.877	
W/H Ratio	0.95	0.06	0.93	0.05	1.850	0.067	
Blood Pressure (mmHg)	Systolic	138.24	8.94	136.72	8.84	0.855	0.395
	Diastolic	91.12	7.51	88.92	6.25	1.593	0.114
Pulse/min	89.44	6.10	88.68	5.22	0.670	0.102	
HAMA	11.68	5.77	11.50	5.27	0.163	0.871	
Lipid Profile (mg/dl)	TC	211.72	38.29	208.74	34.53	0.409	0.684
	TG	151.24	41.30	153.74	39.21	0.310	0.757
	HDL	38.72	3.53	38.08	3.22	0.948	0.346
	LDL	142.75	37.32	139.11	34.29	0.508	0.613
	VLDL	30.25	8.26	30.75	7.84	0.310	0.757

Table 4 shows anthropometric and biochemical parameters in control group at baseline and after 3 months of study period. Decrease in BMI, WHR, Systolic and diastolic blood pressure, pulse rate, lipid profile and HAM-A was recorded after 3 months of

antihypertensive treatment but the differences of mean at 0 and 3 months was statistically insignificant ( $p > 0.05$ ). These findings indicate that the parameters remain controlled and decreased due to antihypertensive medications.



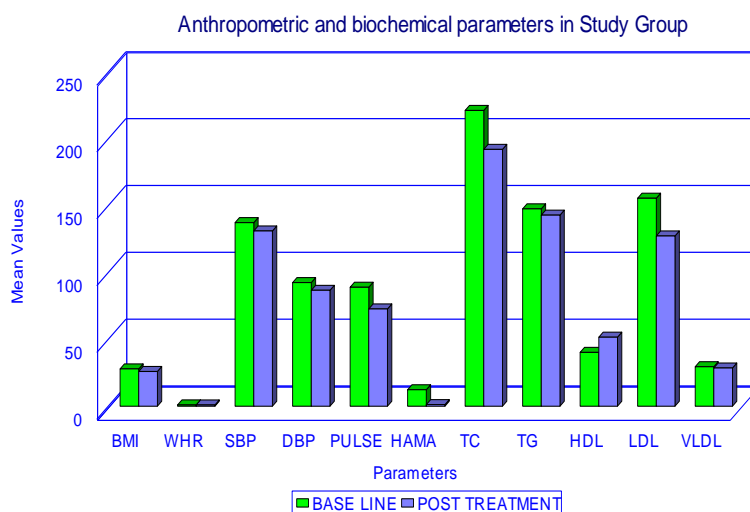
**Fig. 2: Anthropometric and biochemical parameters in control group**

**Table 5: Anthropometric and biochemical parameters in Study Group**

Parameters	Base Line		Post Treatment		t	p	
	Mean	SD	Mean	SD			
BMI (kg/m <sup>2</sup> )	27.90	3.65	25.97	2.94	2.902	0.005	
W/H Ratio	0.96	0.05	0.94	0.04	1.322	0.189	
Blood Pressure (mmHg)	Systolic	137.36	8.10	131.12	6.24	43.14	<0.001
	Diastolic	92.48	6.24	86.72	3.74	5.597	<0.001
Pulse/min	89.00	6.98	72.76	3.91	14.361	<0.001	
HAMA	12.34	6.98	1.20	1.12	11.142	<0.001	
Lipid Profile (mg/dl)	TC	221.26	38.02	192.16	31.67	4.158	<0.001
	TG	147.64	28.78	142.94	31.19	0.783	0.435
	HDL	40.30	5.15	51.62	5.52	10.604	<0.001
	LDL	155.63	43.90	127.40	36.30	3.505	0.001
	VLDL	29.53	5.76	28.59	6.24	0.783	0.435

Table 5 shows difference of means in study group at 0 and 3 months after continuously undergoing SKY intervention along with antihypertensive medicines. A significant decrease was recorded in BMI ( $p < 0.05$ ), Systolic and diastolic blood pressure ( $p < 0.001$ ), pulse rate ( $p < 0.001$ ) and HAM-A ( $p < 0.001$ ). Lipid profile TC

decreased significantly ( $p < 0.001$ ), LDL ( $p < 0.01$ ) while TG and VLDL showed insignificant difference ( $p > 0.05$ ). HDL rose significantly ( $p < 0.001$ ). WHR was not decreased significantly ( $p > 0.05$ ), after 3 months of SKY intervention.



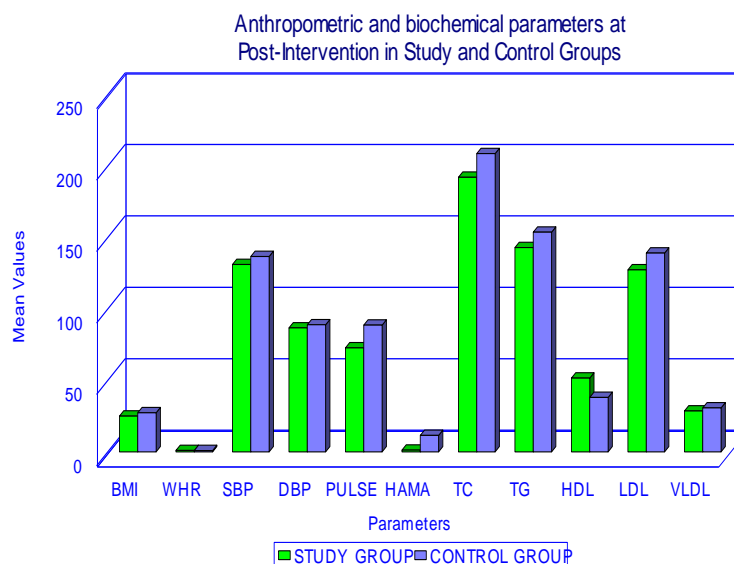
**Fig. 3: Anthropometric and biochemical parameters in study group**

**Table 6: Anthropometric and biochemical parameters at Post-Treatment in Study and Control Groups**

Parameters	Study Group		Control Group		t	p	
	Mean	SD	Mean	SD			
BMI (kg/m <sup>2</sup> )	25.01	3.03	27.36	2.97	2.338	0.021	
W/H Ratio	0.94	0.04	0.93	0.05	1.033	0.304	
Blood Pressure (mmHg)	Systolic	131.12	6.24	136.72	8.84	3.660	<0.001
	Diastolic	86.72	3.74	88.92	6.25	2.136	0.035
Pulse/min	72.76	3.91	88.68	5.22	17.261	<0.001	
HAMA	1.20	1.12	11.50	5.27	13.517	<0.001	
Lipid Profile (mg/dl)	TC	192.16	31.67	208.74	34.53	2.502	0.014
	TG	142.94	31.19	153.74	39.21	1.524	0.131
	HDL	51.62	5.52	38.08	3.22	14.988	<0.001
	LDL	127.40	36.30	139.11	34.29	1.659	0.100
	VLDL	28.59	6.24	30.75	7.84	1.524	0.131

Table 6 depicts the comparison of different parameters between the groups at post-treatment. There was statistically significant difference between the

means of BMI ( $p < 0.05$ ), systolic blood pressure, diastolic blood pressure, pulse rate, HAMA, TC and HDL ( $p < 0.001$ ).



**Fig. 4: Anthropometric and biochemical parameters at post-intervention in study and control group**

**DISCUSSION**

Many hypertensive patients try complementary/alternative medicine for blood pressure control. Numerous herbal remedies, non-herbal remedies like yoga have been tested and some seem to have antihypertensive effects. Yoga has been shown to be a beneficial adjuvant. SKY is a highly standardized package of yoga based intervention applied across entire globe in the same form by the skilled teachers and a need was felt to study its effects in hypertension.

In one study it has been found that there is significant reduction in SBP, DBP, HR as well as respiratory rate after 12 weeks practice of SKY in 30 healthy subjects. The mechanism involved is by creating balance in autonomic nervous system by parasympathetic dominance and decreased sympathetic drive [8].

During breathing exercises synchronization within the hypothalamus and the brainstem is likely to be responsible for inducing the parasympathetic response [9]. Slow Ujjayi breathing enhances parasympathetic activity & increases indicators of vagal tone such as respiratory sinus arrhythmia & heart rate variability. It also decreases chemoreflex sensitivity & improves baroreflex sensitivity [10-12], oxygenation & exercise tolerance. Contraction of laryngeal muscles with partial closure of glottis during slow Ujjayi breathing also stimulates somatosensory vagal afferents [10]. Resistive loading created during ujjayi breathing send afferent input via vagal & spinal sources arising from lung & chest wall structure to parabrachial nucleus & locus coeruleus which also receives projections from NTS, feeding back through dorsomedial nucleus to vagal efferents which in turn slows heart rate by increasing parasympathetic & decreasing sympathetic input to SA node [10, 13] thus decreasing the heart rate. During prolonged voluntary expiration intra-thoracic pressure

increases and blood from the lungs is squeezed into the heart leading to an increase in stroke volume, baroreceptors in carotid sinus experiences more pressure and discharge more, which inhibit discharge of vasoconstrictor nerves and excites the vagal innervations of the heart producing vasodilatation, a drop in systolic blood pressure and bradycardia [14]. Increased baroreceptor discharge inhibits vasomotor centre which leads to decrease in sympathetic tone and peripheral resistance thus reducing diastolic blood pressure [15].

Significant reduction has been found in resting pulse rate, systolic blood pressure and diastolic blood pressure indicating increase in baroreflex sensitivity after yoga training for more than 5 years [16]. Betterment of antioxidant status and anxiety levels by practice of SKY has been demonstrated in healthy adults [4]. A study was conducted to see effect of SKY on hypertensive patients showed that after 2 months practice of SKY there was significant decrease in diastolic blood pressure, serum urea and plasma MDA (Malondialdehyde adducts) as oxidative stress marker. This is suggestive that yogic breathing exercises help in relieving the stresses of life as well as improve antioxidant status and health of the individual [17].

Cortisol ‘stress hormone’ has been found to be significantly reduced after SKY practices suggesting the stress relieving effect of this relaxation technique [18]. A significant reduction in blood pressure in hypertensive patients after 3 weeks of yoga practices clearly indicated gradual improvement in baroreflex sensitivity and progressive attenuation of sympathoadrenal and rennin-angiotensin activity [19]. Isometric exercises are reported to elicit certain beneficial effects on carotid baroreflex system in hypertensive patients [20]. Likewise certain yogic postures may have role in decreasing blood pressure.

In our study patients of hypertension after 3 months of SKY practices showed significant reduction in

Hamilton anxiety score. Cyclical breathing techniques in SKY quiets those cortical areas of the brain that are involved in executive functions like anticipation, planning and worry which is suggestive of antianxiety effect of this relaxation technique [10]. Blood lactate is a biochemical measure of stress. The significant fall in lactate levels after practices of SKY for the first time, suggests that it induces a state of relaxation [21].

Prolactin also called as ‘well being hormone’ is reported to increase while cortisol ‘stress hormone’ decreases with Sudarshan Kriya indicates the stress relieving, relaxant, bonding and anxiolytic effect of this yogic breathing process [1]. Guided meditation during SKY reduces perception of stress, relieves anxiety, decreases O<sub>2</sub> consumption and oxidative stress which shows the beneficial effect on anxiety, hypertension and other psychosomatic diseases [22].

EEG studies during meditation shows increased alfa/delta power and a decrease in the beta/alfa power. There was a better balance and synchrony in the EEG recorded from left and right side which is suggestive of calm alertness, focused, increased concentration not distracted easily [23].

Sahaj yoga meditation relieves stress, anxiety, depression, hypertension. Meditation has direct effect on hypothalamus, it reduces anxiety and stress which further helps in reducing fat deposition thus it is beneficial in reducing BP of hypertensive patients [24].

In our study BMI and lipid profile decreased significantly in study group after 3 months practices of SKY. In some studies lipid profile was found to be significantly decreased after practices of Sudarshan Kriya Yoga [7]. Improved lipid profile due to increased hepatic lipase and lipoprotein lipase at cellular level affects metabolism of lipoprotein and thus increase uptake of triglycerides by adipose tissue [25]. Better ability to overcome stress is beneficial to lower lipid profile [26].



Fig. 5: Measuring blood pressure



**Fig. 5: Giving instructions regarding Yogasan**



**Fig. 6: Ujjayi Pranayam (Stage – I)**



**Fig. 7: Ujjayi Pranayam (Stage II)**



**Fig. 8: Ujjayi Pranayam (Stage III)**

## CONCLUSION

Sudarshankriya yoga showed statistically significant decrease in the values of all the above parameters after 3 months of practice. The mechanism involved is by creating balance in autonomic nervous system functions by parasympathetic dominance and decreased

sympathetic drive. Our study may prove to be helpful in management of hypertension and in those patients who either die of cardiac diseases or live a morbid life with psychosomatic & lifestyle related diseases. To what extent Sudarshankriya Yoga plays role in prevention as well as management of cardiac and mental health further research are needed.

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