

Reversal of Early Atherosclerosis in Metabolic Syndrome by Yoga – A Randomized Controlled Trial

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Abstract

Metabolic syndrome (MetS) is a strong risk factor for Coronary Heart Disease (CHD) and type II Diabetes mellitus (DM). The aim of the present study was to determine whether yoga can regress early atherosclerosis in patients with MetS, as measured by carotid intima thickness (cIMT). 100 adult patients of MetS were randomized to yoga and control group and were followed for 1 year. 81% patients completed the study. At the end of 1 year, the yoga group showed a significant regression of cIMT (0.842 ± 0.176 to 0.808 ± 0.204 , $p < 0.001$) whereas there was no significant change in cIMT in the control group (0.831 ± 0.171 to 0.834 ± 0.131 , $p = \text{NS}$). In addition the yoga group also showed greater reduction in Body Mass Index (BMI), Waist Circumference (WC), LDL cholesterol and Systolic Blood Pressure (SBP). On the basis of this randomized study, we conclude that practice of yoga can regress early atherosclerosis in MetS and has also beneficial effects on several metabolic parameters. The mechanisms of the improvement are not evident from the present study and need further investigations.

Keywords: Carotid intima medial thickness; Coronary heart disease; Type II diabetes mellitus; Atherosclerosis regression; Meditation; Yoga; Metabolic syndrome

Introduction

Metabolic syndrome (MetS), a clustering of risk factors is highly prevalent throughout the world especially in South Asians [1] and is a strong risk factor for Coronary Heart Disease (CHD) and type 2 Diabetes Mellitus (DM) [1-3]. The definition of metabolic syndrome as modified for the south Asians is by the following criteria [2].

1. Central Obesity (defined as waist circumference ≥ 90 cms for males and ≥ 80 cms for females)
2. Raised triglyceride level ≥ 150 mg/dL.
3. Reduced HDL < 40 mg in males and < 50 mg in females
4. Raised blood pressure systolic blood pressure ≥ 130 mmHg and diastolic blood pressure ≥ 85 mmHg and
5. Raised fasting plasma glucose ≥ 100 mg/dL.

Three out of five criteria have to be present to define the metabolic syndrome.

Though lifestyle modifications like physical activity, diet and weight reduction have been shown to be beneficial in MetS, the effects of yoga, a mind body technique have not been adequately studied. Yoga is a holistic lifestyle and includes not only physical postures (asanas), breathing exercises (Pranayamas), meditation but also emphasizes on vegetarian diet, tobacco cessation and stress control. Yoga has been reported to be beneficial for control of risk factors of CHD (like hypertension, diabetes, obesity, lipids and stress) [4-6], regression of advanced coronary atherosclerosis [7-9] and secondary prevention of CHD [10]. The objective of the present study was to determine whether yoga can regress the progression of early atherosclerosis in MetS [11].

Material and Methods

One hundred consecutive apparently healthy individuals of either sex and diagnosed as MetS by modified criteria for south Asians [2] were included in this prospective randomized controlled trial. Patients in the control group ($n=50$) were prescribed the conventional lifestyle modifications (exercise, diet, smoking cessation) while the yoga group

($n=50$) were prescribed yogic exercises, in addition as described below. The patients were selected from the Executive Health Checkup of Sir Ganga Ram Hospital and a written informed consent was taken. The project was cleared by the Ethical committee of the institution. At baseline detailed clinical assessment, biochemical profile and cIMT measurements were performed by B mode ultrasound utilizing the standard methodology [9]. The patients were followed up for 1 year with repeated assessments. At the end of one year, they again underwent detailed clinical examination, biochemical tests and cIMT measurement by the same methodology. The baseline characteristics of the two groups did not differ significantly (Table 1) except for slightly high Systolic Blood Pressure (SBP) in the yoga group.

Yogic Exercises

After inclusion in the yoga group, patients underwent training in various yogic exercises by a trained yoga instructor for one week after which they were instructed to continue these practices daily for about 60 min daily. The yogic practices that were followed in the study have been reported by us earlier [8] and were as follows:

1. Health rejuvenating exercises—these exercises are aimed mainly at improving the general tone and flexibility of various parts of the body. These were also performed during warming up and to prepare for the next step, i.e. the Asanas.
2. Breathing exercises (Pranayamas) (Anulom Vilom—alternate nose breathing, Nadi Shodhana pranayam).
3. Asanas: these are the yogic postures and exercises mainly aimed at stretch relaxation. A number of asanas were taught including

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Surya Namaskar, Tadasana, Padahastana, Vajrasana, Shasankasana, Ardha-matsyendrasana, Paschimottanasana, Bhujangasana, Dhanush ban asana, Shalabhasana, Uttanpadasana, Merudandasana, Pawanmuktasana, Sarvangasana, Matsyasana, Ardha matsyasana. The details of these asanas can be found in standard texts on yogic exercises.

4. Relaxation exercises (Kayotsarg or Corpse Posture) – A method of complete relaxation and preparation of body and mind for meditation. The literal meaning of Kayotsarg is to drop the body. In practice it is the conscious suspension of all gross movements of the body. As a result the muscles relax and the person becomes as restful as in sleep.
5. Preksha Dhyana – Preksha means perception and Dhyana means concentration. Preksha Dhyana is performed in the sitting position and the person first relaxes the body using Kayotsarg. Then he concentrates on the breath and gradually reduces the rate of breathing from 15-17/minute to 10-12/minute. With practice, the rate may be reduced even to 4-6/minute. By concentrating on the breath, the mental activity is controlled and the mind is prevented from being distracted.

In addition, they were advised to follow a low fat vegetarian diet, do moderate aerobic exercises and stop tobacco use.

Patients visited the yoga centre every month for monitoring and evaluation. The compliance as reported by the patients themselves was recorded. The compliance was defined as the percentage of total yogic exercises done at least five days a week.

Results

81 patients (43 controls and 34 in the yoga group) completed the study for one year. 19 patients were lost to follow up mostly because of inability to continue to study due to personal reasons. The compliance of the patients as reported by them in the yoga group was 75 ± 12%.

There was a significant reduction in BMI, WC, LDL, Tg, FBS, HbA1C, SBP and DBP and increase in HDL in both the groups (Table 2), but when compared with control, yoga group had a significant greater decrease in BMI, WC, LDL and SBP levels and increase in HDL. The cIMT decreased significantly in the yoga group whereas there was no significant change in cIMT in the control group. Univariate analysis of change in metabolic variables and change in cIMT in the study group showed that the reduction in waist circumference and HbA1C change correlated significantly with reduction in cIMT at the end of follow up.

Discussion

Our results on chemical and biochemical parameters of metabolic change are consistent with other studies of the effect of yoga/meditation in MetS [12-15]. Khatri et al. [12] reported in a randomized trial those 3 months yogic therapy resulted in a significant improvement in WC, SBP, DBP, fasting blood sugar, HbA1C, serum triglycerides and increase in HDL level. This study however included patient with known type II DM. Paul-Labrador et al. [15] reported that 16 weeks of practice of transcendental meditation (TM) led to a significant reduction in insulin resistance which is considered as the basis of metabolic syndrome.

Our study also shows that the early atherosclerosis (which is often present in MetS) as assessed by cIMT is significantly reduced by 1 year practice of yoga as compared to controls (Figure 1). cIMT has been considered to be a surrogate marker for CHD [16], suggesting that yoga may help in reversal of early coronary heart disease. Another small

	Control group	Study group	p value
Age (in years)	56.74 ± 12.79	62.43 ± 12.49	0.53
Female : Male	1.2:1	0.8:1	0.39
Smoking (%)	54%	57%	0.86
BMI	34.11 ± 4.75	32.98 ± 3.98	0.27
WC (cm)	99.9 ± 7.78	99 ± 4.31	0.50
TC (mg/dL)	230 ± 45.06	240.9 ± 56.48	0.35
LDL(mg/dL)	153.3 ± 52.77	162.5 ± 60.40	0.48
HDL (mg/dL)	47.65 ± 13.63	48.24 ± 15.87	0.83
Tg (mg/dL)	159.7 ± 49.73	152.5 ± 50.34	0.55
FBS mg%	117.8 ± 31.57	124.26 ± 37.19	0.41
HbA1c (%)	5.75 ± 0.63	5.76 ± 0.78	0.98
SBP (mmHg)	157.26 ± 11.75	162.76 ± 10.69	0.037
DBP (mmHg)	93.40 ± 5.56	94.71 ± 6.24	0.34
cIMT (mm)	0.8313 ± 0.171	0.8423 ± 0.176	0.78

BMI – Body Mass Index, WC- Waist Circumference, TC – Total Cholesterol, LDL - Low Density Lipoprotein Cholesterol, HDL - High Density Lipoprotein Cholesterol, Tg – Triglyceride, FBS- Fasting Blood Sugar, HbA1c – Glycosylated Hemoglobin, SBP – Systolic Blood Pressure, DBP – Diastolic Blood Pressure, cIMT – Carotid Intima Media Thickness.

Table 1: Comparison of baseline characteristics of the two groups.

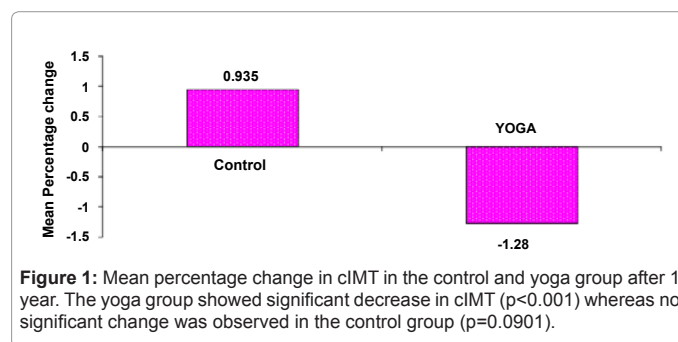


Figure 1: Mean percentage change in cIMT in the control and yoga group after 1 year. The yoga group showed significant decrease in cIMT (p<0.001) whereas no significant change was observed in the control group (p=0.0901).

pilot trial in high risk older subjects demonstrated that after 9 months of multimodality natural medicine program including TM, cIMT was significantly reduced [17]. Three other randomized studies utilizing coronary angiography in patients with advanced CHD have also shown a regression of obstructive atherosclerotic lesions by yoga/meditation [7-9].

The mechanisms underlying the regression of early atherosclerosis in MetS by yoga are not clear from our study. Control of several risk factors like hypertension, type II DM lipids [4-10]. Reversal or preventive effects of both psychosocial and oxidative stress and reduction of inflammation [18-21] may be contributing factors. Further studies are needed to delineate the exact mechanisms.

Our study has several limitations. Relatively small number of patients has been studied and there have been 19% dropouts. By the nature of interventions involved, the study could not be blinded, hence a placebo effect of yoga intervention could not be excluded. The compliance of yoga practices was reported by patients themselves and not directly observed by the investigators. However despite these limitations, outcome variables in the two groups are significantly different and are likely to be clinically important.

Conclusion

On the basis of this randomized controlled trial, we conclude that addition of yoga to the conventional therapy in patients with MetS resulted in a significant reduction of early atherosclerosis as assessed by cIMT. In addition, yoga has additional significant effect on lipids,

Parameter	Control group			Study group			p-value
	Baseline	After 1 year	p value	Baseline	After 1 year	p value	
Weight (Kg)	90.37 ± 13.5	89.14 ± 13.55	0.002	91.62 ± 12.9	86.91 ± 12.53	<0.001	0.001
BMI	34.11 ± 4.75	33.65 ± 4.9	0.003	32.98 ± 3.98	31.29 ± 3.99	<0.001	0.001
WC (cm)	99.9 ± 7.78	98.00 ± 7.3	<0.001	99 ± 4.31	95.12 ± 5.12	<0.001	0.001
TC (mg/dL)	230 ± 45.06	173 ± 25.0	<0.001	240.9 ± 56.48	171.85 ± 25.37	<0.001	0.119
LDL (mg/dL)	153.3 ± 52.77	102.56 ± 30.89	<0.001	162.5 ± 60.40	92.21 ± 28.11	<0.001	0.035
HDL (mg/dL)	47.65 ± 13.63	49.95 ± 11.97	0.017	48.24 ± 15.87	59.15 ± 12.36	<0.001	0.001
Tg (mg/dL)	159.7 ± 49.73	114.86 ± 24	<0.001	152.5 ± 50.34	109.29 ± 29.86	<0.001	0.896
FBS mg%	117.8 ± 31.57	91.95 ± 7.23	<0.001	124.26 ± 37.19	91.65 ± 9.75	<0.001	0.337
HbA1c (%)	5.75 ± 0.63	5.23 ± 0.31	<0.001	5.76 ± 0.78	5.062 ± 0.329	<0.001	0.152
SBP (mmHg)	157.26 ± 11.75	131.95 ± 6.62	<0.001	162.76 ± 10.69	130.35 ± 8.53	<0.001	0.010
DBP (mmHg)	93.40 ± 5.56	82 ± 7.24	<0.001	94.71 ± 6.24	80.88 ± 5.91	<0.001	0.180
cIMT (mm)	0.8313 ± 0.171	0.834 ± 0.171	0.901	0.8423 ± 0.176	0.8077 ± 0.204	<0.001	0.0001

BMI – Body mass index, WC- waist circumference, TC – total cholesterol, LDL - Low density lipoprotein cholesterol, HDL - High density lipoprotein cholesterol, Tg – triglyceride, FBS- Fasting blood sugar, HbA1c – glycosylated hemoglobin, SBP – systolic blood pressure, DBP – diastolic blood pressure, cIMT – carotid intima media thickness.

Table 2: Parameters at baseline and at the end of twelve months in the two groups.

BMI and blood pressure. Yoga may be a cost effective technique to target multiple risk factors for heart disease and type II DM prevention. Though larger trials are required, it is suggested that yoga may be incorporated in the therapeutic lifestyle modifications for metabolic syndrome as well as CHD and type II DM.

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