

## Effect of 6 Months of Meditation on Blood Sugar, Glycosylated Hemoglobin, and Insulin Levels in Patients of Coronary Artery Disease

### Abstract

**Background and Objectives:** Coronary artery disease (CAD) is the leading cause of morbidity and mortality worldwide. It has been recognized that stress, diabetes, and hypertension are important in etiology and progression of CAD. This study is to evaluate the role of meditation in improving biochemical parameters such as blood glucose, glycosylated hemoglobin, and serum insulin levels in known CAD patients. **Material and Methods:** Sixty CAD patients are divided into two groups of which one group did meditation and other did not. Blood glucose, glycosylated hemoglobin, and fasting serum insulin levels were measured before and at the end of 6 months of study in both the groups. **Results:** At the end of the study, significant decrease was seen in patients who practiced meditation as compared to other group. **Conclusion:** Meditation may modulate the physiological response to stress through neurohumoral activation, which may be a novel therapeutic target for the treatment of CAD.

**Keywords:** Coronary artery disease, electrochemiluminescence immunoassay, glycosylated hemoglobin, insulin, meditation

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### Introduction

Coronary artery disease (CAD) is the leading cause of death worldwide, accounting for 22.9% of total deaths, and is projected to increase to 26.3% by 2030.<sup>[1]</sup> The factors that lead to increase the risk of developing atherosclerotic CAD were demonstrated in Framingham in the mid- twentieth century<sup>[2]</sup> and have subsequently been shown to be pervasive across ethnicities and regions of the world.<sup>[3]</sup> These risk factors are smoking, dyslipidemia, obesity, and diabetes; hypertension has been gradually escalating<sup>[4]</sup> and is thought to be the driving influence behind the epidemic of heart disease faced today.

Of the risk factors, diabetes, and its predominant form, type 2 diabetes mellitus (T2DM), has a distinctive association with CAD. Those with diabetes have two- to four-fold higher risk of developing coronary disease than people without diabetes.<sup>[5]</sup> More significantly, however, the age- and sex-adjusted mortality risk in diabetic patients without preexisting CAD was found to be equal to that of nondiabetic individuals with prior myocardial infarction (MI).<sup>[6]</sup> Compared

to cardiovascular disease in nondiabetics, diabetic patients have a greater overall coronary plaque burden and a higher rate of multivessel disease. The proportion of stenotic segments is directly proportional to the duration of disease.<sup>[7]</sup> In combination, these factors place diabetic patients at greater risk for MI. In fact, diabetics without a prior MI are at equal risk for MI as nondiabetics with a prior MI. After MI, complications and death are higher in DM. The increased risk also extends to those undergoing cardiac procedures. After percutaneous coronary intervention, diabetic patients are at both higher risk for death and need for reintervention.<sup>[8]</sup> Diabetic patients who undergo coronary artery bypass grafting are at higher risk for both complications and death, particularly in those with insulin-dependent T2DM, with no benefit seen in those who have had tight postoperative glycemic control.<sup>[9,10]</sup>

These remarkable findings regarding higher risk of mortality<sup>[11-13]</sup> have led to suspicion that common precursors predispose to diabetes and CAD,<sup>[14,15]</sup> with subsequent implications that insulin resistance, visceral adiposity, and excess inflammation<sup>[16-18]</sup>

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underlie the pathophysiology of thrombogenesis. In addition, a complex mix of mechanistic processes such as oxidative stress, enhanced atherogenicity of cholesterol particles, abnormal vascular reactivity, augmented hemostatic activation, and renal dysfunction have been proposed as features characteristic of T2DM that may confer excess risk of CAD.<sup>[19]</sup>

Ornish *et al.*<sup>[20]</sup> were the first to document the beneficial effects of lifestyle changes in reversing the CAD. Manchanda *et al.*<sup>[21]</sup> in their study similarly showed encouraging results with their yoga lifestyle intervention. However, both these studies included only a small number of patients.

“Meditation” is a set of attentional practices leading to an altered state or trait of consciousness characterized by expanded awareness, greater presence, and a more integrated sense of self. Practice of concentrating, focus on an imaginary point on forehead i.e., between eyebrows, sound or object increases awareness of the present moment, reduces stress, promote relaxation, and enhance personal and spiritual growth. Meditation practice self-regulates the body and mind, thereby affecting mental events by engaging into a specific attentional set. These practices are a subset of other practices used to induce relaxation or altered states such as hypnosis, progressive relaxation, and transcendental meditation technique.<sup>[22]</sup> Meditation is a simple mental technique which has well-documented benefits for health and wellbeing.<sup>[23,24]</sup> It can be learned easily by anyone regardless of age, educational background, or culture. The technique is effortless and requires no belief or any change in lifestyle or diet.

During meditation, mental activity settles down in a natural way, while alertness is maintained and even enhanced. Scientific studies reveal that meditation produces a specific physiological response pattern that involves various biological systems. Mechanism most frequently suggested that meditation produces effects including metabolic,<sup>[25]</sup> autonomic, endocrine, neurological, cardiovascular, and psychological responses on a multidimensional interactive basis. The objective of our study was to see the effect of 6 months of meditation on stress level in CAD patients.

## Material and Methods

The study was conducted in Department of Physiology, Biochemistry and Cardiology, Maulana Azad Medical College and associated G. B. Pant Hospital from June 2011 to January 2012. The sample size was calculated by keeping confidence interval between 85% and 95% and confidence level of 95%. The study group comprises of sixty angiographically proven (criteria: 50% or more obstruction in any coronary artery) CAD patients. They were equally divided into two groups, thirty each in meditation and control group, selected from Department of Cardiology,

G. B. Pant Hospital, New Delhi. Randomization to control and meditation group was done with the help of chit method.

Inclusion criteria were (1) age group 30–70 years of either sex, (2) angiographically proven CAD, and (3) nonsmokers. Exclusion criteria were (1) patients with a history of acute MI in recent past (2 months), (2) patients with unstable angina pectoris, (3) patients with clinical cardiac failure, those with ejection fraction of below 30% by echocardiography, (4) patients who had undergone coronary angioplasty or bypass surgery, (5) patients with heart ailments other than CAD such as congenital heart disease and cardiac myopathies, (6) patients with endocrine disorders such as thyrotoxicosis, (7) patients with neurological or psychiatric disorders, and (8) patients who had participated in athletics/sports activity or routinely following yogic exercises.

The patients were equally divided into two groups, each group consisting of thirty patients. Randomization to either group was done with the help of chit method. Yoga group consisted of CAD patients with medication and on prescribed meditation (concentrative meditation) and dietary modifications. Control group consisted of CAD patients with medication and dietary modification. Ethical approval of study protocol and consent from all the patients was obtained before the study. Routine hematological investigations which included hemoglobin, blood sugar (overnight fasting and 2 h postprandial), fasting glycosylated hemoglobin (HbA<sub>1c</sub>), and fasting serum insulin (using electrochemiluminescence immunoassay on Elecsys 2010 automated system using cobas e-immunoassay analyzers kits and results were determined via a calibration curve which is a instrument specifically generated by 2-point calibration and a master curve provided via the reagent barcode) was conducted in the Department of Biochemistry, Maulana Azad Medical College, New Delhi. A volume of 5 ml of fasting peripheral venous blood was collected in plain vials under aseptic conditions and estimation was done.

## Protocol for meditation in meditation group

Patients were called in group of 10 twice a week (Monday and Thursday) at 9 AM in the Department of Cardiology, G. B. Pant Hospital. They were instructed to come empty stomach, wearing clean, simple and loose clothing. They were made to sit comfortably on the floor and allowed to relax for about 5 min. This was to allay any apprehension associated with the class. To ensure free and fresh ventilation, all the windows of the room were opened. The room’s ambient temperature was maintained on all days between 16°C and 20°C. The room was clean, noise-free, and dim lighted. Meditation technique was demonstrated each day for first few days until they had learned the technique perfectly; subsequently, they followed the procedure themselves. Special emphasis was laid on breathing technique practiced by each

patient individually, and the same was checked on each subsequent visit.

### **Meditation technique**

#### *Concentration on body*

Sitting relaxed on the floor, patients were asked to focus attention on their body. Asked to put their attention at the area of forehead, and just sweep the body, feeling every part of body sensations and tensions. If they felt any tensions in their body, they were asked to just be aware of those tensions; do not try to resist or control those tensions and continue sweeping the body.

#### *Concentration on breathing*

Patients were taught to allow their body to breathe naturally and focus their attention wherever they feel the sensation of the breath in the body. While inhaling, be aware, be conscious of inhaling; when exhaling, be aware, and be conscious of exhaling. Be with this movement of the breath; just come back to it as an anchor.

#### *Distress to destress*

Patients were taught that whenever they experience tension, stress, or anxiety, try to focus their attention on other things – Perhaps the sounds they hear, the sensations in their body, the touch of their clothing, movements in their body, their heart beating, or the rise and fall of the abdomen during breathing. They were made to learn to be aware of other things that are happening while they are experiencing stress. Patients practicing meditation can be seen in Figure 1.

#### *Forgiveness*

Patients were taught to gently soften their thought toward themselves, accept themselves as they are, without any notion of what they should become. Making friends with those with whom they really feel that friendship, that kindness. Then only, they can extend that friendship,



**Figure 1: Patients practicing meditation under supervision**

gentleness, softness even to those who have hurt, disappointed, or frustrated them. Letting go of the hurts and wounds they have been carrying by learning to forgive, by learning to accept the common humanness.

To ensure whether patients were doing meditation properly or not, heart rate and blood pressure were recorded before (after 5 min of rest) and after doing meditation. Patients in meditation group were asked to maintain a record diary in which they entered days on which they did meditation and for how long. To ensure their compliance to program at home, they were subjected to stress management intake questionnaire. Any patient not following instructions properly or doing meditation for <5 times in a week was not included in the study.

### **Follow-up**

(1) All the patients were directed to fill up the requisite information with respect to the medication prescribed routinely as per pro forma given, (2) in the meditation group of patient, they were instructed to routinely follow-up the meditation process and to make the entries in the record diary, (3) each patient in control group was instructed to report for follow-up regularly at an interval of 15 days, (4) each patient was instructed to immediately contact the investigator in case of any problem, and (5) at the end of 6 months, biochemical parameters were studied in both the group of patients.

### **Results**

Name of the software used for statistical analysis is IBM SPSS Statistics Data Editor manufactured by International Business Machines Corporation, New York, United States. The data were normally distributed. Name of the test used is Student's *t*-test. The anthropometric measurements of the patients in the two groups are shown in Table 1. There were no statistical difference in the age, height, weight, and body surface area of patients in two groups. Hence, the two groups are statistically comparable to assess the effect of meditation on CAD patients. Patients practicing meditation can be seen in Figure 2.

All sixty patients were taking medications as prescribed by their cardiologist which included antiplatelet drugs such as aspirin, clopidogrel, lipid-lowering drugs (statins), and beta-blocker drugs. Eighteen (60%) patients out of thirty in yoga group and 21 (70%) out of thirty in control group were receiving either angiotensin-converting enzyme inhibitors or diuretics or beta-blockers as antihypertensive therapy for about last 6 months. Six (20%) patients in each group were taking oral hypoglycemic drugs for their diabetes.

Mean  $\pm$  standard deviation (SD) values of routine investigations, namely, hemoglobin, fasting and postprandial blood sugar and glycosylated hemoglobin in the two groups of patients are given in Tables 2 and 3.

Baseline mean  $\pm$  SD of hemoglobin in yoga group patients was  $14.3 \pm 1.4$  g/dl, and at the end of the study, it was  $14.3 \pm 1.6$  g/dl. Blood sugar fasting before and after study in yoga group patients was  $97.2 \pm 11.0$  g/dl and  $91.9 \pm 5.5$  g/dl, respectively, which is statistically highly significant with  $P = 0.002$ . Postprandial blood sugar was  $175.63 \pm 21.66$  g/dl and  $167.6 \pm 14.5$  g/dl before and after study, respectively, which is also statistically highly significant with  $P = 0.001$ . Glycosylated hemoglobin before and after study in yoga group patients was  $5.8\% \pm 0.9\%$  and  $5.6 \pm 0.7$  g/dl, respectively, which is statistically significant with  $P = 0.023$ .

Mean  $\pm$  SD values of baseline mean hemoglobin in control group patients was  $13.2 \pm 1.8$  m/dl, and at the end of the study, it was  $13.4 \pm 1.6$  m/dl. Blood sugar fasting and postprandial in control group patients before the study was  $95.4 \pm 11.1$  m/dl and  $168.2 \pm 29.4$  m/dl, respectively. At the end of the study, they were  $93.3 \pm 7.8$  m/dl and  $165.5 \pm 21.2$  m/dl, respectively. Glycosylated hemoglobin before and after study in control group patients were  $5.8\% \pm 1.1\%$  and  $5.7 \pm 0.8$  g/dl, respectively. However, statistical significance could not be established for any of the parameters before and after the study.

Mean  $\pm$  SD value for serum insulin in yoga group before and after study was  $77.3 \pm 20.2$  pmol/l and  $80.8 \pm 18.3$  pmol/l, respectively. Mean  $\pm$  SD value of serum insulin in control group patients before and after the study was  $83.4 \pm 18.3$  pmol/l and  $88.2 \pm 16.0$  pmol/l, respectively, which was statistically significant. Results are shown in Tables 2 and 3.

## Discussion

CAD remains one of the major causes of morbidity and mortality worldwide. A number of risk factors have been identified to be strongly associated with CAD, diabetes, and stress, and behavior patterns are one of them. Hence, the present study was chosen to study the effect of stress relieving technique, i.e., meditation on biochemical parameters on CAD patients.

When one is exposed to a physical or psychological stressor, the brain initiates a stress response, from which a series of chemical reactions ensue. The stress response is a healthy defense mechanism and involves the release of hormones that have numerous biochemical and physiological effects. However, the continued release of these hormones under conditions of chronic stress can have detrimental effects on health. Indeed, the hormonal response associated with long-lasting stress increases the risk of many diseases, including heart disease, stroke, and angina. Stress hormones also trigger increases in blood pressure, heart rate, and blood sugar and raise the risk of heart attack.<sup>[26]</sup>

The present study was conducted in the Departments of Physiology, Biochemistry, and Cardiology, Maulana Azad Medical College and associated G. B. Pant Hospital, New Delhi, on sixty CAD patients, age group between 30

**Table 1: Mean $\pm$ standard deviation of baseline value of anthropometry in the two groups of patients**

	Mean $\pm$ SD	P (Group I compared with Group II)
Age (years)		
Group I	53.9 $\pm$ 9.8	0.328 (NS)
Group II	56.2 $\pm$ 7.2	
Height (cm)		
Group I	165.5 $\pm$ 4.9	0.690 (NS)
Group II	166.1 $\pm$ 5.9	
Weight (kg)		
Group I	69.5 $\pm$ 6.2	0.173 (NS)
Group II	67.2 $\pm$ 6.3	
BSA (m <sup>2</sup> )		
Group I	1.8 $\pm$ 0.1	0.345 (NS)
Group II	1.7 $\pm$ 0.1	

$P > 0.05$  NS;  $P < 0.05$  S;  $P < 0.01$  HS. NS = Not significant, S = Significant, HS = Highly significant, BSA = Body surface area, SD = Standard deviation

**Table 2: Mean $\pm$ standard deviation values of routine investigations in Group I patients before and after study (n=30)**

Parameters	Before study	After study	P
Hemoglobin (g/dl)	14.3 $\pm$ 1.3	14.3 $\pm$ 1.6	0.720 (NS)
Blood sugar (fasting) (mg/dl)	97.2 $\pm$ 11.0	91.9 $\pm$ 5.5	0.002 (HS)
Blood sugar (postprandial) (mg/dl)	175.6 $\pm$ 21.7	167.6 $\pm$ 14.5	0.001 (HS)
HbA1c (%)	5.8 $\pm$ 0.9	5.6 $\pm$ 0.7	0.023 (S)
Fasting serum insulin (pmol/L)	77.3 $\pm$ 20.2	80.8 $\pm$ 18.3	0.095 (NS)

$P > 0.05$  NS;  $P < 0.05$  S;  $P < 0.01$  HS. NS = Not significant, S = Significant, HS = Highly significant, HbA1c = Glycosylated hemoglobin

**Table 3: Mean $\pm$ standard deviation values of routine investigations in Group II patients before and after study (n=30)**

Parameters	Before study	After study	P
Hemoglobin (g/dl)	13.2 $\pm$ 1.8	13.4 $\pm$ 1.6	0.228 (NS)
Blood sugar (fasting) (mg/dl)	95.4 $\pm$ 11.1	93.3 $\pm$ 7.8	0.093 (NS)
Blood sugar (postprandial) (mg/dl)	168.2 $\pm$ 29.4	165.5 $\pm$ 21.2	0.235 (NS)
HbA1c	5.8 $\pm$ 1.1	5.7 $\pm$ 0.8	0.295 (NS)
Fasting serum insulin (pmol/L)	83.4 $\pm$ 18.3	88.2 $\pm$ 16.0	0.015 (S)

$P > 0.05$  NS;  $P < 0.05$  S;  $P < 0.01$  HS. HbA1c = Glycosylated hemoglobin, NS = Not significant, S = Significant, HS = Highly significant

and 70 years of either sex. These patients were randomly selected and were equally divided into two groups, each group consisting of thirty patients. Of the sixty patients, 56 (93.3%) were males and 4 (6.7%) were females.



**Figure 2: Patients practicing meditation**

At the end of the study, it was seen that there was a statistically significant decline in fasting and postprandial blood sugar levels in patients practicing meditation as compared to those patients not practicing meditation. The statistical analysis showed that the differences were highly significant ( $P < 0.01$ ). However, there was not such finding in nonmeditating group. Glycosylated hemoglobin also showed statistically significant decline in meditation group at the end of study. Medical Meditation of Dharam Singh Khalsa has claimed managing diabetes both type 1 and type 2 by strengthening pancreas which regulates bodies' insulin level by increasing blood flow to the area.<sup>[27]</sup> Recently, a group of researchers at General Hospital at Bangkok studied 50 men and women with T2DM aged 42–80 years over a 3-week trial during which time they measured a blood glucose after eating breakfast; this was followed by meditation with significant improvement in postmeal blood glucose level around 1 mmol/L (18 mg/dL) lower along with significant lowering of blood pressure.<sup>[28]</sup> There was other studies conducted recently demonstrated beneficial effect of meditation in reducing blood glucose level and also improving insulin resistance.<sup>[29,30]</sup> Mention has been made about meditation found to give benefits for people with diabetes and general healthcare improvements. Meditation suppresses stress response reducing plasma cortisol<sup>[31]</sup> which improves glycemic control.

These results suggest that meditation may modulate the physiological response to stress through neurohumoral activation, which may be a novel therapeutic target for the treatment of CAD. Previous work by Reaven *et al.*<sup>[32]</sup> and Brook and Julius<sup>[33]</sup> has suggested that sympathoadrenal system activation is linked with the CAD. Visceral obesity, insulin resistance, and diabetes are also associated with a pro-inflammatory state<sup>[34,35]</sup> that is linked with elevated CAD risk.<sup>[36]</sup> The present study results expand this understanding and demonstrate that meditation, which is believed to reduce sympathoadrenal system activation,

beneficially alters the insulin resistance components of the metabolic syndrome and hence reduces CAD risk.

These current results also expand our causal understanding of the role of stress in the rising epidemic of the CAD. Although current low levels of physical activity, unhealthy eating habits, and resultant obesity are triggers for this epidemic, the demands of modern society may also be responsible for higher levels of chronic stress.<sup>[37]</sup> Stress activates the neurohumoral system, specifically the sympathoadrenal system and the hypothalamic–pituitary–adrenal axis that involves catecholamine release, vagal withdrawal, cortisol secretion, and upregulation of the renin–angiotensin system.<sup>[38]</sup> Acute psychological stress has also been demonstrated to increase interleukin-6 levels,<sup>[39]</sup> possibly owing to stress-induced catecholamine activation. Interleukin-6 also appears to activate the hypothalamic–pituitary–adrenal axis, increasing the hypothalamic secretion of corticotrophin-releasing hormone and responsiveness of the anterior pituitary release of corticotropin and adrenal secretion of cortisol.<sup>[40]</sup>

There is tremendous enthusiasm in cardiac rehabilitation circles to incorporate complementary forms of exercise therapy such as yoga and meditation to the mainstream practice of cardiac rehabilitation. Lack of infrastructure, expertise, and funding seem to be the main hurdles in the implementation of such reform. Therefore, more research needs to be carried out at leading rehabilitation centers into the benefits of complementary physical exercise modalities and a push for more funding is required once there is unequivocal evidence of the benefits of its incorporation into the mainstream post- and pre-event cardiac rehabilitation.

### Limitations of the study

Acute psychological stress has also been demonstrated to increase interleukin-6 levels, possibly owing to stress-induced catecholamine activation. The study could have included this parameter to see the effect of meditation on this stress-related marker. Brain activity of CAD patients could have been recorded with the help of an encephalogram during meditation to see the effect of meditation.

### Conclusion

In the present study, it was concluded that there is significant decrease in the blood sugar and glycosylated hemoglobin levels in CAD patients practicing meditation for a period of 6 months and significant increase in fasting serum insulin levels in CAD patients not practicing meditation. Our findings are also in compliance with the study conducted by Hegde *et al.*<sup>[41]</sup> on the effect of 3-month yoga practice on oxidative stress in type 2 diabetics. Yoga practitioners achieved significant improvement in body mass index, fasting blood glucose level, postprandial blood glucose, glycosylated hemoglobin, glutathione, and

Vitamin C at 3 months compared with the standard care group. Gordon *et al.*<sup>[42]</sup> also reported 20% reduction in oxidative stress and decrease in blood glucose level.

Sudsuang *et al.*<sup>[43]</sup> have shown that practising Dhammakaya Buddhist meditation produces certain biochemical and physiological changes and reduces the reaction time (the interval time between the presentation of a stimulus and the initiation of the muscular response to that stimulus). They reported a significant increase in serum total protein and reduction in serum cortisol levels in male individuals of age 20–25 years. Vandana *et al.* studied the impact of Integrated Amrita Meditation Technique (IAMT) on adrenaline and cortisol levels in healthy college students (age 18–21 years). They reported that IAMT has long-term efficacy in reducing the levels of these two stress hormones, within-group comparisons, i.e., before the start of IMAT and during the follow-up period up to 8 months.<sup>[44]</sup>

The results of the present study demonstrate that practicing meditation reduces blood glucose and glycosylated hemoglobin concentration in CAD patients and that changes were more marked in yoga group. It can be concluded from the present study that meditation helps in improving health status of an individual including blood glucose and glycosylated hemoglobin levels. Furthermore, the practice should be adopted and continued for a long duration.

#### Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

#### Conflicts of interest

There are no conflicts of interest.

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