Effect of 3-Month Yoga on Oxidative Stress in Type 2 Diabetes With or Without Complications

A controlled clinical trial

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OBJECTIVE—To assess the effect of yoga on anthropometry, blood pressure, glycemic control, and oxidative stress in type 2 diabetic patients on standard care in comparison with standard care alone.

RESEARCH DESIGN AND METHODS—The study involved 123 patients stratified according to groups with microvascular complications, macrovascular complications, and peripheral neuropathy and without complications and assigned to receive either standard care or standard care along with additional yoga for 3 months.

RESULTS—In comparison with standard care alone, yoga resulted in significant reduction in BMI, glycemic control, and malondialdehyde and increase in glutathione and vitamin C. There were no differences in waist circumference, waist-to-hip ratio, blood pressure, vitamin E, or superoxide dismutase in the yoga group at follow-up.

CONCLUSIONS—Yoga can be used as an effective therapy in reducing oxidative stress in type 2 diabetes. Yoga in addition to standard care helps reduce BMI and improve glycemic control in type 2 diabetic patients.

Diabetes Care 34:2208–2210, 2011

Oxidative stress has been implicated as the root cause underlying the development of insulin resistance, β-cell dysfunction, diabetes, and its associated clinical conditions such as atherosclerosis, microvascular complications, and neuropathy (1,2). Yoga has been found to be beneficial in reducing oxidative stress in type 2 diabetes (3,4), but there is a lack of controlled trials to demonstrate the same. This report describes the effect of yoga on oxidative stress, glycemic control, blood pressure control, and anthropometry in type 2 diabetic patients with or without complications compared with control subjects on standard care.

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Diabetes Care 34:2208–2210, 2011

DOI: 10.2337/dc10-2430. Clinical trial reg. no. CTRI/2011/05/001739, ctric.nic.in.

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**CONCLUSIONS**—Yoga practitioners achieved a 2% reduction in oxidative stress, which is similar to the findings of Gordan et al. (10). A 6-month intervention conducted by Arroyo et al. (11, 12) using a similar lifestyle intervention also showed a 15% reduction in oxidative stress. Our study is the first to report a 60% reduction in oxidative stress associated with yoga intervention. Other lifestyle interventions such as aerobic exercise and resistance training have been shown to improve antioxidant parameters (11, 12). Antioxidant supplements such as vitamins E and C improved oxidative stress in 60% of the study population compared with standard care.

Yoga practitioners achieved significant improvements in BMI, FG, PPG, HbA1c, malondialdehyde, glutathione, and vitamin C levels and waist circumference. The mean percentage reduction in HbA1c was 2.5% (0.5 ± 0.3%) in the yoga group compared with a 0.8% reduction in the control group. The mean percentage reduction in malondialdehyde was 2.9% (1.4 ± 0.3%) in the yoga group compared with a 0.7% reduction in the control group. Of the 15 patients in the yoga group, only one patient (6.7%) had a 2.4% increase in HbA1c, whereas, in the control group, the mean percentage increase in HbA1c was 0.7% (0.5 ± 0.6%). Significant changes in waist circumference, blood pressure, vitamin E, or superoxide dismutase were not observed in the yoga group compared with control groups. No serious adverse events were observed during the intervention period.

### Table 1—Parameters at baseline and after 3 months

| Parameter                          | Baseline | After 3 months |
|-----------------------------------|----------|----------------|
| BMI                               |          |                |
| FG                                |          |                |
| PPG                               |          |                |
| HbA1c (%)                         |          |                |
| Malondialdehyde (μmol/L)          |          |                |
| Glutathione (μmol/L)              |          |                |
| Waist circumference (cm)          |          |                |
| Diastolic blood pressure (mmHg)   |          |                |
| Systolic blood pressure (mmHg)    |          |                |

**Figure 1**—The mean percentage reduction in oxidative stress, in the yoga group compared with the control group. **Figure 2**—Comparison of the mean percentage reduction in oxidative stress between the yoga group and the control group. **Figure 3**—The mean percentage reduction in oxidative stress in the yoga group compared with the control group.
Yoga effect on oxidative stress in diabetes

at several community centers in the city, which made it easy for the patients to attend the classes; in addition, culturally, Indian patients would accept yoga better than the Western population.

Our study is limited by the fact that the allocation to the groups was not randomized. Random allocation in community settings is difficult. In this study, social and environmental factors during these training sessions may have a beneficial influence on oxidative stress. The strength of our study was the stratification of sample according to complications. Participants with various complications may have increased oxidative stress; stratification made the two groups identical.

In conclusion, yoga can be used as an effective therapy in reducing oxidative stress in type 2 diabetes. Yoga is also beneficial in improving glycemic parameters and BMI and can be administered as an add-on therapy to standard lifestyle interventions. Yoga was not beneficial in reducing the blood pressure or waist circumference in this short-term study. Further studies are needed to confirm that yoga is beneficial in preventing the progression of diabetes and its complications.

Acknowledgments—This study was funded by a grant from Manipal University (431/013/2007).

No potential conflicts of interest relevant to this article were reported.

S.V.H. designed the study, acquired and interpreted data, and wrote the manuscript. P.A. developed the protocol, designed the study, interpreted data, and reviewed and edited the manuscript. S.K. analyzed data. V.J.P. acquired data and contributed to discussion. S.D. and V.D. reviewed and edited the manuscript.

The authors thank Laura Prakash, School of Public Health, University of Minnesota, Minneapolis, MN, for her contribution to the study. The authors express appreciation to the participants whose cooperation and dedication made this study possible. The authors also acknowledge International Training and Research in Environmental and Occupational Health (ITREOH) training grant from Fogarty Foundation, which was responsible for their training in medical writing.

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