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# YOGA AS A THERAPEUTIC TOOL FOR AUTONOMIC MODULATION AND SUBJECTIVE WELLBEING IN TYPE 2 DIABETIC PATIENTS: A PILOT STUDY

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**ABSTRACT**

**Background:** Autonomic neuropathy is a frequent cause of morbidity in diabetic individuals.

**Aim:** To explore the effect of different yoga modalities of Ananda Yoga on autonomic modulation and wellbeing in diabetic patients.

**Method**: It was a single blind, non invasive, pilot study. Autonomic parameters and subjective wellbeing were assessed using biofeedback (HRV) monitor and a questionnaire respectively.

**Results:** The mean SDNN in Resting, Energization Exercise, Yoga postures, Meditation and Post session was 29.82±8.89, 59.38±37.48, 45.02±14.86, 38.1±16.96 and 60.13±62.06 respectively. The mean LF in ms² was 252.71±252.66, 778.84±673.53, 399.83±378.05, 769.93±766.03 and 437.55±411.43 respectively. The mean HF in ms² was 141.28±159.52, 377.28±543.15, 133.91±99.54, 265.87±293.45 and 173.85±216.09 respectively. Improvement in subjective wellbeing was statistically significant ($p < 0.05$)

**Conclusion:** A single session of Ananda Yoga showed statistically significant autonomic modulation and subjective wellbeing improvement in patients of type 2 diabetes. Further studies are needed to explore the benefits of yoga.

**KEYWORDS :** Diabetes, Yoga, Autonomic function, Heart rate variability

## INTRODUCTION

Diabetic autonomic neuropathy is a frequent cause of morbidity and mortality among diabetic individuals (1–3).Autonomic nervous system abnormalities may occur quite early in the course of diabetes, followed by a continued gradual decline (4–5). Early detection of subclinical autonomic dysfunction in diabetic individuals is important for risk stratification and subsequent management, possibly including pharmacologic and lifestyle interventions (6).

Although, Heart rate variability (HRV) can detect cardiac autonomic impairment in diabetic individuals as several large population-based cohorts have reported associations between low HRV and prevalent diabetes (7-10), but little is known about management strategies to reverse this autonomic impairment. Strategies that target autonomic imbalance and inflammation may have the potential to delay and/or prevent type 2 diabetes and its complications (11). In addition to therapeutic lifestyle changes, restoration of HRV has been demonstrated using increased physical activity, deep breathing, β-adrenergic blockers, aldose reductase inhibitors, ACE inhibitors, angiotensin receptor blockers, potent antioxidants like alpha-lipoic acid, and inhibitors of peroxynitrite formation (12).

Certain yoga modalities hold promise to modulate autonomic nervous system. Participants who completed a pranayama program showed significant reduction in heart rate and multiple indices of cardiac autonomic function (13-14). On subjective front, studies have found improvement in multiple domains of quality of life and psychological wellbeing (15-16).These studies open the possibility of making yoga practices a low cost intervention to improve T2DM management.

Authors have found that the available studies so far have not assessed the individual effect of different yoga modalities on autonomic modulation in diabetic individuals. Moreover it is speculated that studying the effect of standardized yoga intervention protocols will enhance applicability of these tools in clinical therapeutics.

With these objectives in mind, we conducted a pilot study to explore the effect of different yoga modalities of Ananda Yoga- Energization exercises, Yoga postures, Pranayama-Meditation on autonomic modulation in diabetic patients and also studied their effect on subjective wellbeing through questionnaire based scoring system.

## RESEARCH METHODS

### Study design

It was a single blind, non invasive, exploratory study. All the participants were given a brief overview of the trial in the beginning and were asked to sign an informed consent. A 40 minute yoga session was lead by an experienced yoga instructor.

Inclusion criteria consisted of diabetic patients having a sedentary lifestyle with no regular schedule of any form of exercise.

Exclusion criteria consisted of diabetic patients with cardiac arrhythmia or ectopics on resting ECG or patients with severe restricted mobility of spine or joints that made participants unsuitable to participate in the study.

### Study tools

The research tools of the study consisted of both subjective parameters of wellbeing and an objective biofeedback (HRV) monitor. Before the yoga intervention, the demographic characteristics like age, gender and duration of diabetes and clinical parameters were noted. Participants were asked to fill the questionnaire for subjective physical and mental wellbeing on a scale of 0 to 10, before and after the session.

To evaluate cardiac autonomic modulation during performance of different yoga modalities, HRV evaluation in blocks of 5min each for individual patient was recorded in the following sequence- Pre-session/Energization Exercises/Yoga postures/Pranayama-Meditation /Post-session The HRV monitor used in the study was Chronovisor Dx Data acquisition system. Standard Time and Frequency Domain Analysis of HRV were carried out as per guidelines of task force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology (1996).

### Intervention

Each yoga session was subdivided into five phases-

Phase 1: Resting phase: 5min

Here participants were sitting in chairs for 5 minutes during which their baseline HRV parameters were recorded. They were asked to record their scores of subjective wellbeing based on questionnaire.

### Phase 2: Exercise phase: 7min

It started with a 5-7 cycles of full yogic breath were subjects had to exhale completely while bending forward flexing their torso on hip joints and touching their feet or ankles with their hands and then slowly lifting up inhaling completely while lifting the torso above and raising the arms above their heads. This was followed by a sequence of Energization exercises. These exercises were originally invented in 1920 by yoga master Paramhansa Yogananda . It involves coordinated breathing with alternate tensing and relaxing of individual muscles by using our will. It is a set of 39 such exercises but to keep it convenient for the study protocol we shared only ten of them.

**Phase3: Yogasana phase: 20min**

In order to keep the postures simple for yoga naive subjects only standing poses were kept in the study protocol. These were -Vrikasana, Veerbhadrasana and Muktasana.

**Phase 4: Pranayama and Meditation: 3min**

In this session for first one minute (approx.) even count breathing was practiced where inhalation and exhalation was kept equal to a count of four for three cycles guided by the instructor. Participants were asked to practice three cycles of even count breathing on their own by keeping a mental count. In last two minutes subjects were asked to practice observation of breath without controlling it by keeping the mind focussed within the nostrils.

**Phase 5: Post session resting: 5min**

Here participants were asked to stay in silence in sitting position.

**Statistical Analysis**

Comparison of HRV parameters in different modalities with resting baseline was analyzed using Wilcoxon signed rank test. Chi –square tests and t-tests were used to compare the differences of the subjective wellbeing scores of the participants before and after the session.

## RESULTS

**Demographic and Clinical Characteristics**

n=11 (5 men and 6 women). The mean age of the participants in years was 46.36±4.94, the mean BMI in Kg/sq. m was 27.38±5.03. The average duration of disease in years was 6.72±4.45.

**Table 1: Mean HRV Characteristics (Frequency and Time Domain Analysis) and their P values using Wilcoxon Signed rank test**

| Study Block | SDNN | TP ($ms^2$) | LF ($ms^2$) | LF nu | HF ($ms^2$) | HF nu | LF/HF | AHR |
|---|---|---|---|---|---|---|---|---|
| Resting | 29.82 8.89 | 884.23 498.36 | 252.71± 252.66 | 63.99± 16.62 | 141.28± 159.52 | 36± 16.62 | 2.22± 1.22 | 80.75± 7.30 |
| Energization Exercise | 59.38 37.48 | 2760.2 2269.45 | 778.84± 673.53 | 73.75± 11.11 | 377.28± 543.15 | 26.25± 11.11 | 3.61± 2.30 | 93.24± 8.28 |
| Yoga Postures | 45.02 14.86 | 1835.57± 103.24 | 399.83± 378.05 | 75.48± 9.06 | 133.91± 99.54 | 24.51± 9.06 | 3.68± 1.98 | 93.18± 7.17 |
| Meditation | 38.1± 16.96 | 1653.59±1290.43 | 769.93± 766.03 | 74.69± 13.3 | 265.87± 293.45 | 25.3± 13.3 | 4.14± 2.71 | 80.75± 8.24 |
| Post-session | 60.13 62.06 | 1639.6 1150.41 | 437.55± 411.43 | 73.55± 14.38 | 173.85± 216.09 | 26.44± 14.38 | 3.82± 2.27 | 81.80± 8.18 |
| Resting with Exercise | 0.004** | 0.0024** | 0.0052** | 0.0681 | 0.0329* | 0.0681 | 0.0475* | 0.0018** |
| Resting with Yoga Postures | 0.0087* | 0.0087** | 0.0217* | 0.0392* | 0.4364 | 0.0392* | 0.0436* | 0.0018** |
| Resting with Pranayama-Meditation | 0.0392* | 0.0268** | 0.0068* | 0.0139* | 0.011* | 0.0139* | 0.0139* | 0.4562 |
| Resting with Post session | 0.0018** | 0.011* | 0.0217* | 0.0268* | 0.3372 | 0.0268* | 0.0329* | 0.2611 |

**statistical significance P < 0.05 ** High statistical significance P < 0.005**

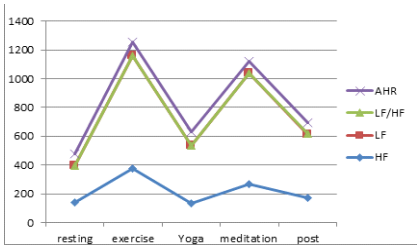


**Fig 1: Line diagram showing comparative results of HRV characteristics with different yoga modalities**

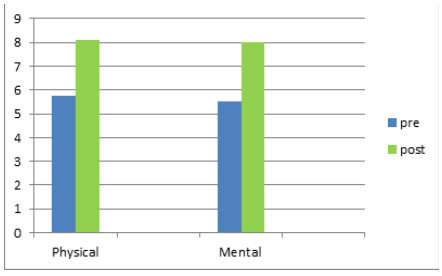


**Fig 2: Bar chart showing improvement in Subjective wellbeing pre and post yoga session**

## DISCUSSION

**Autonomic modulation**

Mean SDNN during all modalities of Ananda Yoga used in the study showed statistically significant variance when compared with the resting state. This indicates that all Ananda Yoga modalities used in the study affect cardiac autonomic modulation individually.

During Energization Exercises a statistically significant increment in LF ($ms^2$), HF ($ms^2$), Total power ($ms^2$) and Average Heart Rate (AHR) was observed. This could be interpreted as autonomic modulation with both sympathetic and parasympathetic components but with overall sympathetic dominance as there was an overall rise in AHR. It is interesting to observe that despite subjects being diabetic and yoga naive energization exercises showed a significantly measurable parasympathetic component. These results correspond with the findings of a recent meta-analysis done by Villafaina et al where they found that statistically significant improvement in HRV parameters was observed with a session ranging from 30-75min of aerobic exercise done at a frequency of 2-7 days per week. (17).The results in our study are noteworthy as significant increment was observed with a 5min single session of exercise.

Authors feel that this difference could be because of the fact that the Energization Exercises used in this study intervention are specific yogic exercises invented by Paramhansa Yogananda, which are different from aerobic exercises. Some of these exercises involve double/deep inhalation and exhalation which may explain increment in HF ($ms^2$) found during exercise. Moreover as these exercises involve tensing and relaxing of individual set of muscles by consciously engaging our will, it is quite possible that these exercises are capable of bringing an additional parasympathetic component apart from sympathetic component by consciously engaging the prefrontal cortex of our brains or there could be modulation of autonomic nervous system happening in hither to unknown ways. It would be interesting and therapeutically rewarding to scientifically explore this particular yoga modality through further that may offer us deeper insights.

During yoga posture rise in LF ($ms^2$) and AHR and fall in HF ($ms^2$) was observed when compared with the resting state. Now this may suggest that rise in AHR was due to both components of sympathetic drive and vagal withdrawal. Here our results partially correlate with findings of VInutha et al where they found that integrated yoga therapy in type 2 diabetic patients showed increment in power of LF, HF and AHR. (18) It is noteworthy to see that the participants of our study were all yoga naive and since all the yoga postures in the intervention were standing poses with arms either raised above the heart or kept parallel to the heart, we did expect autonomic modulation with a sympathetic dominance.

During pranayama-meditation phase, both LF ($ms^2$) and HF ($ms^2$) showed statistically significant increment when compared with the resting state. On the contrary mean AHR was found to be same as at resting baseline. This finding appears paradoxical because with the significant rise in LF which is a marker of sympathetic modulation a rise in mean AHR was expected. We may interpret this finding as suggestive of higher parasympathetic modulation during pranayama-meditation which was balancing or overwhelming the effect of sympathetic drive to give the net effect of unchanged AHR.

Here our results do not match with the findings of Vinutha et al on HRV parameters with deep breathing practice. (18) We speculate that greater sympathetic drive observed during pranayama and meditation could be due to modulated increase in levels of neurotransmitters like-nor adrenaline, dopamine and serotonin. The recent study done by Michael Melnychuk at Trinity College of Neuroscience, Trinity, gives more evidence in this regard. Authors found that breath practices involving focused observation modulates the activity of locus coeruleus which in turn regulates the release of nor adrenaline. (19)

**Subjective wellbeing**

A single 30 min multi modality session of Ananda Yoga could uplift the subjective wellbeing scores by more than 40 percent in physical wellbeing and 45 percent in mental wellbeing when compared with the resting baseline. The statistically significant improvement in subjective wellbeing scores of participants found in our study add to the available evidence that yoga practice is an effective tool to alleviate stress related morbidity in T2DM. Since most of the studies in past have highlighted that the magnitude of perceived stress determines the overall long term risk of many diabetes related complications this enhanced perception of subjective well being physically and psychologically has a potential to curtail long term complications of diabetes. (15-16)

Moreover since these findings were observed in a single session of yoga practice, we have reasons to believe that continued consistent practice of yoga can enhance emotional wellbeing and improve quality of life in T2DM. These benefits can later indirectly translate into greater glycaemic control as well.

## CONCLUSION

Single yoga session of Ananda Yoga with multiple modalities was found to bring statistically significant effect on cardiac autonomic modulation and subjective wellbeing in type 2 diabetic patients. It can be used as a cost effective tool to address diabetes related morbidity. Future trials may shed more light on therapeutic application of these tools.

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