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Effect of yogic techniques on Heart Rate Variability in Polycystic Ovarian Syndrome patients

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Abstract:

Background*: Autonomic dysfunction is known to occur in Polycystic Ovarian Syndrome (PCOS) patients. Effects of yogic techniques on autonomic dysfunctions in these patients are not well studied.*

Aim*:We aimed at studying the effects of yogic techniques on PCOS patients having autonomic dysfunction by recording Heart Rate Variability (HRV).*

Method*: The study was carried out in the Department of Physiology in collaboration with the Department of Obstetrics and Gynaecology at Lady Hardinge Medical College, New Delhi. Thirty newly diagnosed PCOS cases having autonomic dysfunction were enrolled in study and HRV was recorded on them. They were then advised yogic practices for a period of 12 weeks. After 12 weeks HRV was again recorded. Results were compared using the Wilcoxon rank sum test.*

Results*: Pre-yoga PCOS patients HRV parameters were- mean Standard Deviation of normal-to-normal intervals (SDNN)=40.18±4.87, mean Square root of the mean squared differences of successive NN intervals (RMSSD)=32.17±3.55, mean low frequency (LF)=69.65±2.85, mean high frequency (HF)=30.34±2.51, mean LF: HF ratio=2.91±0.32. Post-yoga their HRV parameters were-mean SDNN=44.13±5.96, mean RMSSD=32.82±3.69, mean LF= 63.32±2.85, mean HF= 36.17±2.71 and mean LF: HF= 2.12±0.20. With the practice of yoga, there was a significant increase in values of HF ($p<0.001$) and a decrease in values of LF ($p<0.001$) and LF: HF ratio ($p<0.001$) depicting an improvement in HRV.*

Conclusion*: Yogic techniques effectively improve HRV in PCOS patients with autonomic dysfunction.*

Keywords: *PCOS, Heart Rate Variability, Autonomic dysfunction, Yogic techniques.*

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I. Introduction

Polycystic ovary syndrome (PCOS), is a complex disease of unknown etiology with significant co-morbidity [1]. PCOS is defined as a heterogeneous, multisystem endocrinopathy in women of reproductive age with the ovarian expression of various metabolic disturbances and a wide spectrum of clinical features. It is characterized by reproductive disturbances including chronic anovulation, hyperandrogenism, and polycystic ovaries [1]. PCOS is also associated with multiple systemic manifestations such as hypertension, insulin resistance resulting in multiple complications.

Many of these manifestations arise from increased sympathetic activity which is increased in patients with PCOS as shown in multiple studies [2,3]. Autonomic nervous system plays a significant rolein the PCOS as shown by increased sympathetic and decreased parasympathetic components and increased sympathetic to parasympathetic ratio of HRV [2]. Involvement of the sympathetic nervous system in PCOS is further strengthened by the finding of a greater density of catecholaminergic nerve fibers in polycystic ovaries [4] and altered peripheral catecholamine secretion in adolescent PCOS [5]. Adrenergic overactivity is an important prognostic factor for the development of cardiovascular disorders [6-8]. In recent years, yoga has become increasingly popular for dealing with stress, improving qualityof life, treating a number of psychiatric and psychosomatic disorders, and improving psychologicalfunction [9]. Mind-body practices, like yoga, tend to facilitate autonomic flexibility, enhance self-regulation and induce a 'relaxation response'which is characterized by parasympathetic dominance and reduced sympathetic activation [10,11]. The measurement of HRV is a new research tool used as an index of ANS balance influencing myocardial stability. Till date, many studies have shown ANS imbalance in PCOS patients, also many studies have depicted an improvement in ANS function by yogic practices. All these studies showing improvement were done on healthy volunteers [12-14]. To the best of our knowledge,no studieshave been done on the effects of yogic practices on autonomic dysfunctions in PCOS patients.

Aim of study
We aimed to study prospectively, effects of yogic practices on ANS imbalance in PCOS patients.

II. Material and methods (Figure 1)

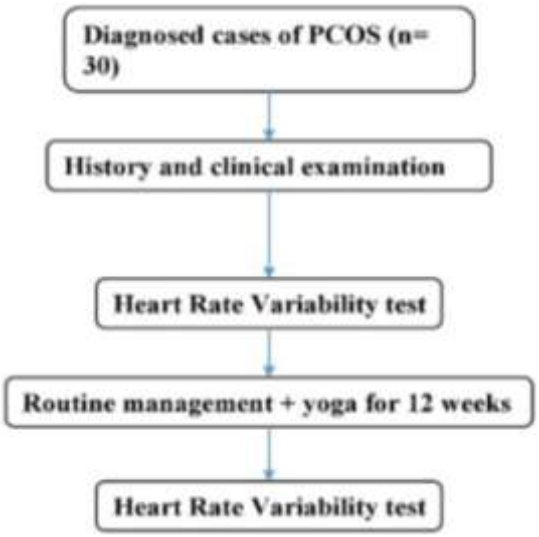
The study was carried out in Department of Physiology, Lady Hardinge Medical College in association with Department of Obstetrics and Gynaecology at Smt. S.K Hospital.
The study has been carried out from Nov 2015 to March 2017.
Study approval was taken from the institutional ethical committee.
Study design: Prospective intervention pilot study.
Sample size: As our study is pilot, the sample size was conveniently taken as 30.
Study population: Newly diagnosed patients of PCOS by Department of Obstetricsand Gynaecology at Smt. S.K Hospital, aged 20-35 years, fulfilling the inclusion and exclusioncriteria, and who were voluntarily attending the Department of Yoga, Naturopathy and Lifestyle Intervention at Lady Hardinge Medical College for Yogic practices and consenting for the study were evaluated and subjected for inclusion and exclusion criteria.

Inclusion criteria:
1.Newly diagnosed patients of PCOS patients as per Rotterdam's criteria having clinical autonomic dysfunction
Rotterdam's criteria (Revised 2003 criteria) [15]
Two of three required for diagnosis
i) Oligo- or anovulation,
ii) Clinical and/or biochemical signs of hyperandrogenism
iii) Polycystic ovaries and exclusion of other aetiologies (congenital adrenal hyperplasia, androgen-secreting tumors, Cushing's syndrome)
2. Age between 20-35 years
3. Patients who volunteered for yogic practices as a part of their lifestyle intervention

Exclusion criteria:
1. Patients on any drugs that influence HRV measurements as antihypertensives, antianginals, antipsychotics or antidepressants etc.
2. Patients on any medication known to affect endocrine profile (oral contraceptives, steroids)or autonomic nervous system(ANS) (antihistaminics, bronchodilators, anticholinergicdrugs, antiarrhythmics, sedatives).
3. Patients with a history of thyroid disease, any serious illness / chronic diseases like cardiacdisorders, hypertension, severe asthma, neurological disorders, psychiatric disorders.
4. Patients following any other regular exercise regimen were excluded.

All those patients satisfying inclusion criteria and exclusion criteria were enrolled in the study.

Figure: 1-Flowchart depicting the study protocol



Heart Rate Variability

HRV is a statistical measure of the cyclic beat-to-beat variation of heart rate, which correlates with the individual autonomic tone and is used to quantify risk in a wide variety of both cardiac and noncardiac disorders [16]. Heart rate variability (HRV) measurement from electrocardiographic recordings has been shown to be useful to assess cardiac autonomic function [16]. The frequency-specific fluctuations in heart rate behavior and the sympathetic/parasympathetic integrity can be evaluated noninvasively with the power spectrum analysis of HRV. The high-frequency component (HF 0.15–0.40 Hz) represents vagal control of heart rate, whereas low-frequency component (LF 0.04–0.15 Hz) and the ratio of LF to HF represent sympathetic modulations or sympathovagal balance [16]. Diminished HRV is associated with increased sympathetic and decreased vagal modulation.

Participants were asked to lie down supine after the ECG electrodes wereplaced on the right arm, left arm, and right foot. They were instructed to close the eyes and to avoid talking, moving hands, legs and body. Then, 5minutes segment basal recording of Heart Rate Variability (HRV) was done after 15 minutes of rest. The data was stored in a system and analyzed using a software program developed by the R&D of Recorders and Medicare System, Chandigarh, India. HRV was recorded and analyzed as per the guidelines of Task Force of European Society of Cardiology and The Northern American Society of Pacing Electrophysiology (1996).Five-minute segment basal recordings were recorded and analyzed to obtain the time domain parameters and frequency domain parameters. Results were obtained in a printed format containing the name of the participant, identity number and statistical results.

a) Time Domain Measures:

In this method, statistical tools are applied to quantify the variations in R-R intervals and thefollowing parameters are computed.

1) SDNN: Standard Deviation of NN intervals.
2) RMSSD: Square root of the mean squared differences of successive NN intervals.

b) Frequency Domain Measures:

The HRV power spectrum was computed from the Fast Fourier transform analysis (FFT).
Frequency domain indices which are defined by specific frequency ranges were studied.

1) Low frequency (LF) - 0.04 to 0.15 Hz
2) High Frequency (HF) - 0.15 to 0.4 Hz
3) LF: HF Ratio

The frequency domain parameters were also measured in normalized units as LF (nu) and HF (nu).

The recordings of participants were carried out in the Department of Physiology, Lady HardingeMedical College and Associated Hospitals. They were asked to come in the postmenstrual phase of their menstrual cycle, after an overnight fast and were instructed to abstain from tea or coffee or nicotine in any form for at least 24 hours before the recording. The participants were made accustomed with the laboratory settings and were briefed about the procedure and apparatus to be used. The objective and design of the study were explained and written informed consent was obtained from both the patients and controls. A semi-structured Performa was filled with all relevant details and their height and weight were recorded. The recordings of Heart Rate Variability (HRV) were taken between 9 a.m. and 12 noon to obviate any diurnal influences.

Intervention

The cases then started lifestyle modification in the form of Integrated Yogic practices comprising of asanas, pranayama, and meditation for 60 minutes on 6 days a week for a period of 12 weeks. They were trained individually by a trained Yoga instructor at Department of Yoga, Naturopathy and Lifestyle Intervention at Lady Hardinge Medical College. After learning yoga techniques by the instructor for two weeks, the patients continued yogic practices at home and maintained a diary. The patients, then, visited the department once a week with the diary and practiced the techniques in front of the instructor. The yogictechniques were prepared by the AYUSH doctor andincluded the following:

I. Kriya: - 5 Minutes

1. AgniSar Kriya
2. Kapalbhati Kriya

II. Asanas: including various Standing Series, Supine Series, Prone Series and Sitting Series of Asanas – 30 minutes

III. Shavasana – 5 minutes

IV.Pranayama – 20 minutes

1. Suryabedhan

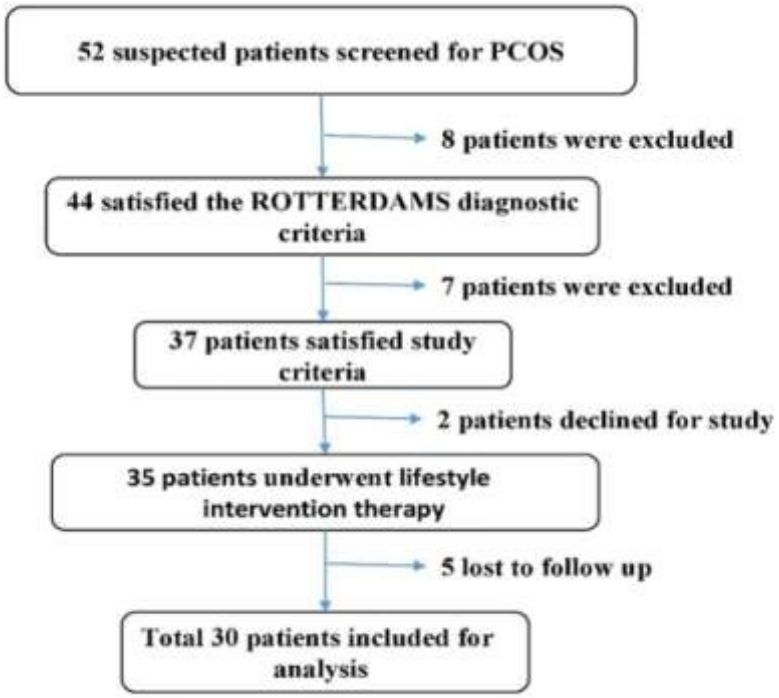
2. Anulomvilan
3. Bhramari
4. Om chanting
5. Maun

Post-intervention:
The HRV has repeatedagain, after 12 weeks, in patients to study the effects of yoga.

Statistical Methods:
All continuous variable expressed in mean and standard deviation. All pre and post-intervention parameters compared using Wilcoxon rank sum test.

III. Results

Figure: 2- Study flow diagram



Total 52 patients of suspected PCOS were screened, 44 satisfied the Rotterdam's diagnostic criteria. After applying inclusion and exclusion criteria, 37 patients were eligible and included in the study. Of these, 2 patients later declined for study participation and were excluded. Total 35 patients underwent lifestyle intervention therapy, of which 5 patients lost to follow up or left in between and were excluded. Finally, total 30 patients were included in the analysis (figure:2).The patients mean age was 26.33±0.39and mean BMI was 25.66±0.65. Baseline values of HRV were SDNN 40.18±4.87, RMSSD 32.17±3.55 (figure:4), LF 69.65±2.85(nu), HF 30.34±2.51(nu), LF/HF ratio 2.91±0.32 (figure:5). After 12 weeks of yoga, the values were – BMI 24.33±0.56 (figure:3), SDNN 44.13±5.96, RMSSD 32.82±3.69, LF 63.32±2.85(nu), HF 36.17±2.71(nu), LF/HF 2.12±0.20 (Table 1).

With yoga practices there was a highly significant decrease in LF (nu) ($p<0.001$) and LF: HF Ratio ($p<0.001$), indicating a change towards decrease in sympathetic activity whereas HF (nu) ($p<0.001$) showed statistically significant increase, suggesting a distinct increase in the parasympathetic tone of the autonomic function in our subjects which is a very encouraging observation regarding the beneficial effect of Yoga on Autonomic Nervous System in our subjects. No significant findings were reported in time domain analysis of HRV i.e. RMSSD and SDNN. Normally, both RMSSD and SDNN reflect a high-frequency variability in heart rate i.e. a parasympathetic influence on the heart [13]. In our study, though RMSSD and SDNN in the Yoga group showed a beneficial trend towards rising although it failed to achieve statistical significance ($p>0.05$).
The RMSSD which is the square root of the mean squared differences of successive RR intervals, along with SDNN is a measure which is sensitive to HF variations in the heart rate and suggests a greater parasympathetic influence on the heart. Our observations suggest a trend towards improvement in time domain parameters of HRV with Yoga.

Table 1- Pre and post-yoga parameters of BMI and HRV

PARAMETERS	Pre- yoga (n=30)	Post- yoga (n=30)	P- value
BMI (Kg/m^2)	25.66±0.65	24.33±0.56	<0.001
HRV PARAMETERS			
SDNN	40.18±4.87	44.13±5.96	0.376
RMSSD	32.17±3.55	32.82±3.69	0.147
LF (nu)	69.65±2.85	63.32±2.85	<0.001
HF (nu)	30.34±2.51	36.17±2.71	<0.001
LF: HF Ratio	2.91±0.32	2.12±0.20	<0.001

Figure: 3 – BMI in PCOS patients before and after Yoga practices

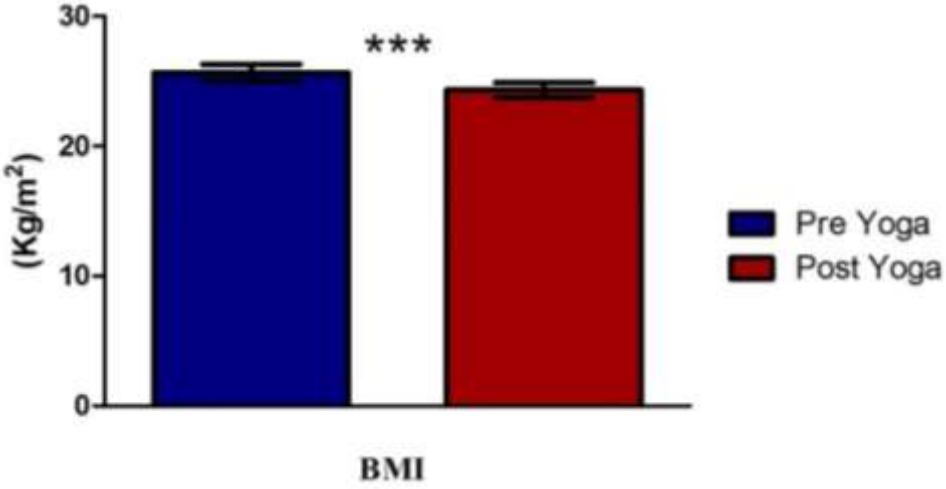


Figure: 4 - Changes in RMSSD and SDNN in PCOS patients before and after yoga practices

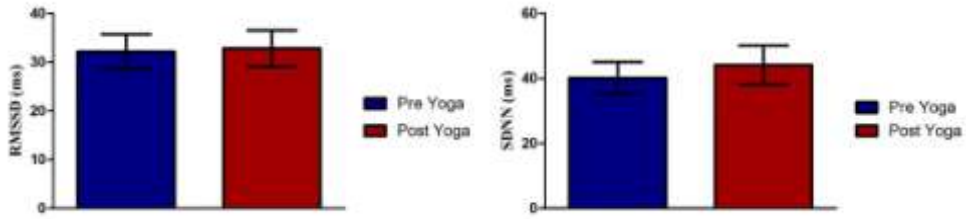
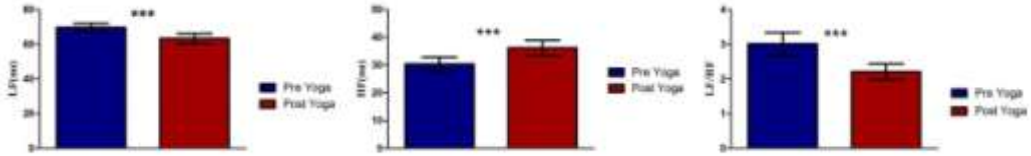


Figure: 5 - Changes in LF (nu), HF (nu) and LF/HF ratio in PCOS patients before and after yoga practices



IV. Discussion

Many of the features of PCOS are associated with chronic sympathetic dominance [18]. Also, the basal heart rate which is mainly under vagal modulation is reported to be high in women with PCOS as a result of decreased vagal activity [19]. The sympathovagal imbalances expose these patients to cardiovascular morbidities [20]. Moreover, researchers observed raised systolic and diastolic blood pressure (BP) in these women and attribute this increment to increased sympathetic drive as regulation of BP is mainly under sympathetic control [21]. Autonomic nervous system plays a significant role in the PCOS as shown by increased sympathetic and decreased parasympathetic components and increased sympathetic to parasympathetic ratio of HRV [2]. Involvement of the sympathetic nervous system in PCOS is further strengthened by the finding of the greater density of catecholaminergic nerve fibers in polycystic ovaries [4] and altered peripheral catecholamine secretion in adolescent PCOS [5]. Adrenergic overactivity is an important prognostic factor for the development

of cardiovascular disorders [6]. A few studies have shown a slight impairment in Heart Rate Variability (HRV) in these women [2].

A study by Yildirir et al. [2], conducted on 30 PCOS patients and 30 controls, demonstrated that PCOS patients had significantly higher LF nu ($P = 0.005$) and LF/HF ratio ($P = 0.001$) and significantly lower HF ($P=0.006$) and HF nu ($P < 0.001$) compared to controls, thereby, concluding that autonomic innervation of the heart can be affected in PCOS with increased sympathetic and decreased parasympathetic components of HRV [2]. Another study by Saranya et al. [20] on 30 PCOS patients and 30 control, showed that the cases of PCOS had significantly increased BMI, waist: hip ratio, basal heart rate, systolic BP and diastolic BP. Also, the ratio of low-frequency to high-frequency power of HRV (LF-HF ratio), the marker of sympathovagal balance was significantly increased in cases compared to controls. Time-domain indices of HRV and fasting blood glucose were increased in cases. They, thusconcluded that PCOS patients have altered autonomic modulation in the form of increased sympathetic and decreased parasympathetic activity. The sympathovagal imbalance exposes them to cardiovascular morbidities [20].

Our current study attempted to investigate the effect of Yogic practices on autonomic function (recorded by HRV). HRV of PCOS patients in the present study showed significant improvement in frequency domain analysis, suggesting a distinct increase in the parasympathetic tone of the autonomic function in our subjects which is a very encouraging observation regarding the beneficial effect of Yoga on Autonomic Nervous System in our subjects, after 3 months of continuous Yoga practices.

Few studies have evaluated the effect of yogic practices on ANS. Markil et al [12] found that Yog-Nidra and relaxation produced significant changes from baseline in HR, R–R interval, pNN50, LF in % and HF in % in 20 young men and women. Hyorim et al. [13]demonstrated in 28 healthy young women undergoing cyclic meditation, a significant decrease in LF (nu), increase in HF (nu) and LF and HF in absolute powers, reduction in LF/HF ratio and a significant increase in pNN50, pNN30 and RMSSD compared to control women. Telles et al [14] had similar findings to report in 40 healthy males undergoing *dhyana* of a significant increase in the skin resistance level, decrease in the heart rate and breath rate, decrease in LF power, increase in the HF power in the frequency domain analysis of the HRV. All these studies were of shorter duration of yoga practice than ours thereby giving much more credibility to our study.

Not all studies on Yoga demonstrate a convincing effect on HRV in participants like ours. Papp et al [22] have reported that in nine out of 12 participants, a significant increase in HRV on pNN50% was recorded but there were no significant changes in other HRV measures such as NN50, LF, HF, LF/HF ratio, LF, HF, and RMSSD post Yoga [22]. One reason for their findings could be very low sample size and shorter duration of study than ours.

To our best of knowledge, this is the first study evaluating the effect of yogic practices on ANS imbalance in PCOS patients. Our study clearly shows that yogic practices have a positive influence on ANS imbalance in PCOS patients, though not all parameters reached to the significant level, they definitely showed positive trends. We believe our study can form the basis of further research with possible larger sample size and randomization.

Our study has few drawbacks like small sample size, non-randomization with lack of control arm. Also, the clinical implication of improved HRV trends needs to be evaluated.

V. Conclusion

The present study on the effects of Yoga on PCOS patients demonstrates that there is a significant improvement in cardiac autonomic activity with parasympathetic dominance as depicted by HRV in these patients after practicing Yoga for 3 months. This suggests that Yoga could be a powerful tool to attenuate the autonomic dysfunction in PCOS patients and thereby decreasing cardiovascular morbidity in them.

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