

Effect of short-term meditation training in central serous chorioretinopathy

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Purpose: Stress and Type A personality are established risk factors for the development of central serous chorioretinopathy (CSC). Meditation is known to have a positive effect on reducing stress levels. This study aimed to assess the effect of short-term meditation training in patients of CSC. **Methods:** A pilot study was conducted where 40 patients diagnosed with acute and non-resolving CSC were randomly assigned to either of two groups – meditation training and routine care (without meditation). The primary outcome measure was time to resolution of CSC based on optical coherence tomography and fluorescein angiography. Secondary outcome measures were changes in anxiety score (State-Trait Anxiety Inventory [STAI] scores) and blood pressure. The patients were followed up for a minimum period of 4 months. **Results:** Twenty cases were included in each group. The demographic pattern, baseline swept-source optical coherence tomography parameters, and STAI scores were similar in both groups. The time to disease resolution was 9.4 ± 4.22 weeks in the meditation group and 19.5 ± 2.79 weeks in the nonmeditation group ($P < 0.001$). At 4 months, CSC had failed to resolve in 60% of patients with routine care compared with 8% in cases following short-term meditation training. STAI scores showed a reduction in stress levels in the meditation group. Furthermore, statistically significant improvement in systolic and diastolic blood pressures was also observed following meditation training. **Conclusion:** Short-term meditation training may be a useful approach in the management of patients with CSC as it tends to reduce stress and prehypertension, and promotes earlier resolution of the condition. However, patient's motivation to complete and pursue the meditation training is a significant barrier.

Key words: Central serous chorioretinopathy, meditation, optical coherence tomography, stress

Primary involvement of the retinal pigment epithelium (RPE) and choroid is seen in central serous chorioretinopathy (CSC). However, the exact mechanism of involvement is unknown. Various speculations about the pathogenesis have been made involving hyperpermeability of the choroid, RPE dysfunction, overaction of mineralocorticoid receptors, increased scleral rigidity, and dysregulation of the choroidal vascular supply.^[1-7] Thus, various treatment modalities targeting different pathways are considered for the management of CSC. These include conventional laser, photodynamic therapy, subthreshold retinal laser, intravitreal antivascular endothelial growth factor (in the presence of secondary choroidal neovascularization), and oral mineralocorticoid receptor antagonist.^[1,8]

The association of CSC and psychological factors have been well described in the literature. Psychological stress is a known risk factor for the development of CSC. Type A behavior, highly competitive individuals, compulsive workaholics, and pregnancy are other risk factors associated with CSC.^[9,10] These conditions are known to be associated with increased hypercortisolism and increased steroid and catecholamine

levels.^[11] Experimental studies have shown that stress plays an important role in causing focal permeability changes in the choriocapillaris and loss of adherence of the pigment epithelium to Bruch's membrane.^[3] Stress can also lead to a repeated increase in blood pressure, which is also considered an important risk factor associated with CSC.^[11-13] Other risk factors for CSC include the use of corticosteroids and obstructive sleep apnea.^[14,15]

Meditation is known to reduce stress levels and thus have important beneficial effects.^[16-19] However, its role in CSC is not well-described in the literature. Herein, we conducted a pilot study to analyze the beneficial effects of short-term meditation training on the anatomical and functional outcomes in cases with CSC.

Methods

This is a pilot prospective, randomized study where the effect of meditation therapy on the natural history of CSC was evaluated. Ethics approval was obtained from the Institutional Ethics Committee (IECPG-581/8.12.16, RT-31/22.03.17), and

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informed consent was taken from all patients. The study is in accordance with the principles of the Declaration of Helsinki. Cases diagnosed as CSC in the retina clinic of a tertiary apex center in India from April 2017 to July 2018 were considered. Patients more than 18 years of age with CSC and without any prior treatment and presenting with ocular symptoms for the first time were enrolled in the study. The diagnosis was primarily based on clinical examination and optical coherence tomography (OCT). Clinically, the presence of pigment epithelial detachment and subretinal fluid (SRF) with OCT showing dilated choriocapillaris suggested the diagnosis of CSC. Fundus fluorescein angiography (FFA) was done at baseline. Cases with multifocal leaks on FFA, RPE changes, and macular pathology other than CSC were excluded from the study. Also, patients with psychosomatic ailments and those taking corticosteroids or other medications (e.g., antihypertensive drugs) known to affect the autonomic system were excluded. The cases were randomly divided into two groups – meditation training and routine follow-up (no meditation training) – by simple randomization and followed up at Weeks 4, 8, 12, and 16 at least.

Patient demographic data, relevant history regarding onset, duration of symptoms, similar past history, corticosteroid use, prior treatment, history of hypertension, and perceived stress were documented. General and systemic examinations were done. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured at the baseline and at 4 weeks using a digital sphygmomanometer. The patient's anxiety level was measured at baseline and at 4 weeks by using the State-Trait Anxiety Inventory (STAI) – Y1 and Y2 anxiety scoring system [Fig. S1] by a single, competent investigator (GN). STAI is one of the commonly used measures of trait anxiety and state anxiety. The State Anxiety Scale evaluates the current state of anxiety, asking how respondents feel "right now," using items that measure subjective feelings of apprehension, tension, nervousness, worry, and activation of the autonomic nervous system. State anxiety items include "I am tense; I am worried" and "I feel calm; I feel secure." The Trait Anxiety Scale evaluates relatively stable aspects of "anxiety proneness," including general states of calmness, confidence, and security. Trait anxiety items include "I worry too much over something that really does not matter" and "I am content; I am a steady person." Form Y has 20 items for assessing trait anxiety and 20 items for state anxiety. All items are rated on a 4-point scale, and each subtest is scored ranging from 20 to 80. A cutoff point of 39 to 40 indicates significant anxiety levels.^[20]

All cases underwent complete ophthalmic examination, including presenting visual acuity (VA) using Snellen VA chart (converted to decimal form), contrast sensitivity using Pelli-Robson chart, intraocular pressure using noncontact tonometer, and anterior segment and posterior segment examination. The VA and contrast sensitivity were repeated at each follow-up visit. At the baseline, clinical fundus imaging, FFA (Spectralis, Heidelberg Angiography) and swept-source optical coherence tomography (SS-OCT; Topcon DRI OCT Triton plus) were performed. SS-OCT was used to look for the presence of SRF and to measure the central macular thickness (CMT) and choroidal thickness (CT). The CMT and CT were measured subfoveally and 500 μm on either side and an average of three readings was considered. The resolution was characterized by the absence of neurosensory detachment (NSD) on OCT. Patients showing no resolution at 16 weeks were regularly followed up at frequent intervals (4 weeks) to determine the time to resolution. OCT was

repeated at each follow-up visit, whereas fluorescein angiography was repeated only in cases with the persisting disease.

Meditation protocol

The total duration of meditation practice was 4 weeks. The first 2 weeks of meditation training were under supervision at the Integral Health Clinic (IHC) in the Department of Physiology at our institute. The next 2 weeks of meditation were undertaken by the patients themselves without any supervision. The patients were first registered at IHC, and consent was taken by the yoga instructor overseeing the meditation practice. The total duration of meditation training was 1 hour every day from 10.30 a.m. to 11.30 a.m. The meditation protocol included (in order) breathing exercises (Pranayama), Sukshma Vyayama, and Shavasana for 20 minutes each.

The primary outcome measure in this study was the time to resolution of CSC. Resolution was defined based on the absence of NSD on SS-OCT. Secondary outcome measures included changes in CMT, CT, VA, contrast sensitivity, and blood pressure. Data were serially entered in a Microsoft Excel worksheet, and statistical analysis was performed with the help of Stata software (Version 12.0, Stata Corporation, College Station, Texas, USA) using *t* test (parametric test), Mann-Whitney test (nonparametric test), and Pearson Chi-square test.

Results

Of the 20 patients in the meditation training group, we had to exclude eight patients from the analysis because they had failed to complete the required training. Thus, effectively 12 cases (13 eyes) were included in the meditation group with one case being bilateral. The two groups were statistically similar in baseline demographic characteristics. The age of the patients was comparable in both the groups, with patients in their second to sixth decade. All cases were males in both groups except one female in the meditation group. At baseline, the VA (0.43 vs. 0.38), contrast sensitivity (1.33 vs. 1.23), SBP (135 vs. 134 mmHg), DBP (87 vs. 86 mmHg), CMT (392 vs. 363 μm), and CT (409 vs. 434 μm) were not significantly different in both the groups [Table 1]. The median duration of symptoms was 4 months (range 7 days to 2 years).

Baseline STAI Y1 score in meditation and control group was 46.3 ± 1 and 45.5 ± 1.5 , respectively ($P = 0.9$), whereas the STAI Y2 score was 45.8 ± 1.9 and 46.5 ± 2.3 , respectively ($P = 0.13$). After 1 month follow-up, the STAI Y1 score was 41.65 ± 3 and 44.1 ± 3.4 in meditation group and control group, respectively ($P = 0.01$), whereas the STAI Y2 score was 41.6 ± 3 and 44.2 ± 3.5 , respectively ($P = 0.008$). The scoring results inferred the presence of anxiety in both groups at the baseline and follow-up. A decreasing trend was seen in both STAI Y1 and STAI Y2 scores in both the groups at the follow-up but was statistically significant in the meditation group ($P = 0.001$ in the meditation group and 0.09 in the nonmeditation group for both STAI Y1 and STAI Y2). In the meditation group, SBP and DBP had significantly decreased from 135 ± 11 and 87 ± 7.5 mmHg, respectively, to 126 ± 11 ($P < 0.001$) and 83.6 ± 7.4 ($P = 0.002$) mmHg, respectively. In the control group, the SBP and DBP had decreased from 134 ± 17 and 86 ± 9.7 mmHg, respectively, to 129 ± 13 ($P = 0.05$) and 84.8 ± 7.5 ($P = 0.24$) mmHg, respectively. Thus, a statistically significant reduction of both SBP and DBP was seen following meditation training, whereas patients in the control group showed no significant reduction in DBP and SBP.

Table 1: Baseline characteristics of meditation and nonmeditation groups

Parameters	Meditation group		Nonmeditation group		P
	Mean±SD	Range	Mean±SD	Range	
Age	38±6.55	24-49	41.2±10.25	25-62	0.24
VA	0.43±0.29	0.01-1	0.38±0.30	0.01-1	0.68
Contrast sensitivity	1.33±0.24	1.05-1.65	1.23±0.40	0.15-1.65	0.42
SBP	135±11	108-150	134±17	98-176	0.74
DBP	87±7.5	73-98	86±9.7	57-101	0.74
CMT	392±162	206-755	363±119	221-628	0.55
Choroidal thickness	409±86	285-620	434±83	285-634	0.40
STAI Y1	46.3±1	45-47	45.5±1.5	42-48	0.9
STAI Y2	45.8±1.9	44-51	46.5±2.3	40-51	0.13

SD=standard deviation, VA=visual acuity, SBP=systolic blood pressure, DBP=diastolic blood pressure, CMT=central macular thickness, STAI=State-Trait Anxiety Inventory

FFA showed leakage in all cases with CSC at baseline. The most common type of leak was “pinhead” leak (60.8%). The other types of leaks seen were “inkblot” in 30.6% and “smokestack” leak in 8.6%. Resolution was characterized by the absence of NSD on SS-OCT. The time to disease resolution in the meditation group was 9.4 ± 4.22 weeks, which was significantly shorter than in the cases not practicing meditation (19.5 ± 2.79 weeks; $P < 0.001$). Twelve of 20 cases (60%) in the nonmeditation group had persistence of leakage at the end of 16 weeks, whereas only one of 13 eyes (7.69%) in the meditation group had persistence of leakage at 16 weeks ($P < 0.001$). Thus, cases practicing meditation had an earlier and complete resolution of CSC.

In the meditation group, CMT decreased from $392 \pm 162 \mu\text{m}$ at baseline to $217 \pm 33 \mu\text{m}$ at 16 weeks ($P = 0.02$) and from $363 \pm 119 \mu\text{m}$ at baseline to $292 \pm 92 \mu\text{m}$ at 16 weeks in the nonmeditation group ($P = 0.08$) [Fig. 1b]. A significant difference between the two groups was seen from the 12th week onward ($P = 0.05$ at 12th week and 0.008 at 16th week). The CT in the meditation group significantly decreased from $409 \pm 86 \mu\text{m}$ at baseline to $271 \pm 52 \mu\text{m}$ at 16 weeks ($P = 0.002$). In the nonmeditation group, the CT decreased from $434 \pm 83 \mu\text{m}$ at baseline to $425 \pm 58 \mu\text{m}$ at 16 weeks ($P = 0.23$) but was not statistically significant [Fig. 1a]. A significant difference between the two groups was seen from fourth week onward ($P = 0.03$ at 4 weeks and < 0.001 at 16 weeks). The VA in the meditation group significantly improved from 0.43 ± 0.29 at baseline to 0.82 ± 0.3 at the end of the 16th week ($P = 0.004$), whereas that in the nonmeditation group improved from 0.38 ± 0.30 at baseline to 0.54 ± 0.35 at the end of the 16th week ($P = 0.002$) [Fig. 1c]. Contrast sensitivity had improved significantly from 1.33 ± 0.24 at baseline to 1.52 ± 0.2 at the 16th week in the meditation group ($P = 0.005$) and from 1.23 ± 0.40 at baseline to 1.38 ± 0.4 at the 16th week in the nonmeditation group ($P = 0.010$) [Fig. 1d, Table 2]. Thus, we note that there was a statistically significant improvement in VA and contrast sensitivity from baseline despite incomplete resolution of CSC in the control group.

Discussion

CSC is usually a self-limiting benign disease with spontaneous resolution occurring in 90% to 95% cases within 3 to 4 months. About 5% to 10% of cases may progress to chronic CSC, while recurrence is seen in 30% to 50% cases over the long

term.^[21-23] In chronic CSC, persistent fluid accumulation leads to progressive and irreversible damage to the photoreceptors.^[22,24] Now, CSC is considered among one of the most common vision-threatening diseases of the retina after age-related macular degeneration, diabetic retinopathy, and branch retinal vein occlusion. Hence, interventions that hasten the resolution of CSC are important to consider. One way of achieving this would be to reduce the duration and influence of the established risk factors.

The pathogenesis of CSC is still poorly understood, and several factors may be involved.^[1-7] Stress and anxiety have been highlighted as predominant factors.^[9-11] Hence, we tried to address this modifiable aspect in CSC pathogenesis. The beneficial effects of meditation therapy on stress and hypertension is very well-known.^[19,25,26] In CSC cases, meditation therapy may have some beneficial effect, but there is no evidence available in literature regarding this. In this study, the beneficial effects of short-term meditation training on the anatomical and functional outcomes in cases with acute CSC are documented and compared with those who did not receive any meditation therapy.

Anxiety is defined as a feeling of unease, stress, tension, and worry.^[27] It can be evaluated using different parameters and questionnaires. In our study, it was evaluated using the STAI Y scoring system. STAI is used to measure the state and trait anxiety in an individual. The state anxiety is the anxiety of a person about an event, and the trait anxiety is the anxiety level as a personal characteristic. Higher scores are considered to correlate with higher anxiety levels. The current version Form Y is simple with better indicators of different anxiety levels.^[28,29] Baseline STAI Y1 and Y2 scores were similar in the two groups showing an increased and similar level of state and trait anxiety in both these groups. Both STAI Y1 and Y2 scores had significantly decreased after 4 weeks of meditation. This showed that meditation therapy was beneficial in reducing the stress levels in individuals ($P < 0.001$ for STAI Y1 and Y2). The SBP and DBP had also significantly decreased in the meditation group suggesting systemic benefits of meditation. This decrease in blood pressure may be related to the decline in stress levels.

Our results suggest that cases who practiced meditation had an earlier resolution. Correspondingly, there was a better restoration of CMT and CT in these patients. Functionally, this

translated to an early improvement of VA. VA had significantly improved in both the groups at the end of the 16th week, but the positive change was seen from the fourth week itself in those performing meditation. Contrast sensitivity too showed a significant improvement in both the groups but with no difference with regard to time.

Meditation is a form of mind–body medicine that combines physical postures, meditative/relaxation, and breathing techniques.^[19] This study shows that meditation had a beneficial effect on stress and blood pressure. Stress

and hypertension are known to be important risk factors for CSC.^[7,11-13] Decrease in stress and blood pressure may be one of the reasons for early resolution of CSC. State and trait anxiety are known to affect sleep patterns also.^[30] Meditation by relieving stress and anxiety may help in improving sleep patterns. As sleep disorders are known to be among the risk factors for CSC, meditation may additionally benefit by improving sleep patterns. However, polysomnography was not included in this study and is a limitation. A major limitation of this pilot study is the high number of patients who had to be excluded for not completing meditation training

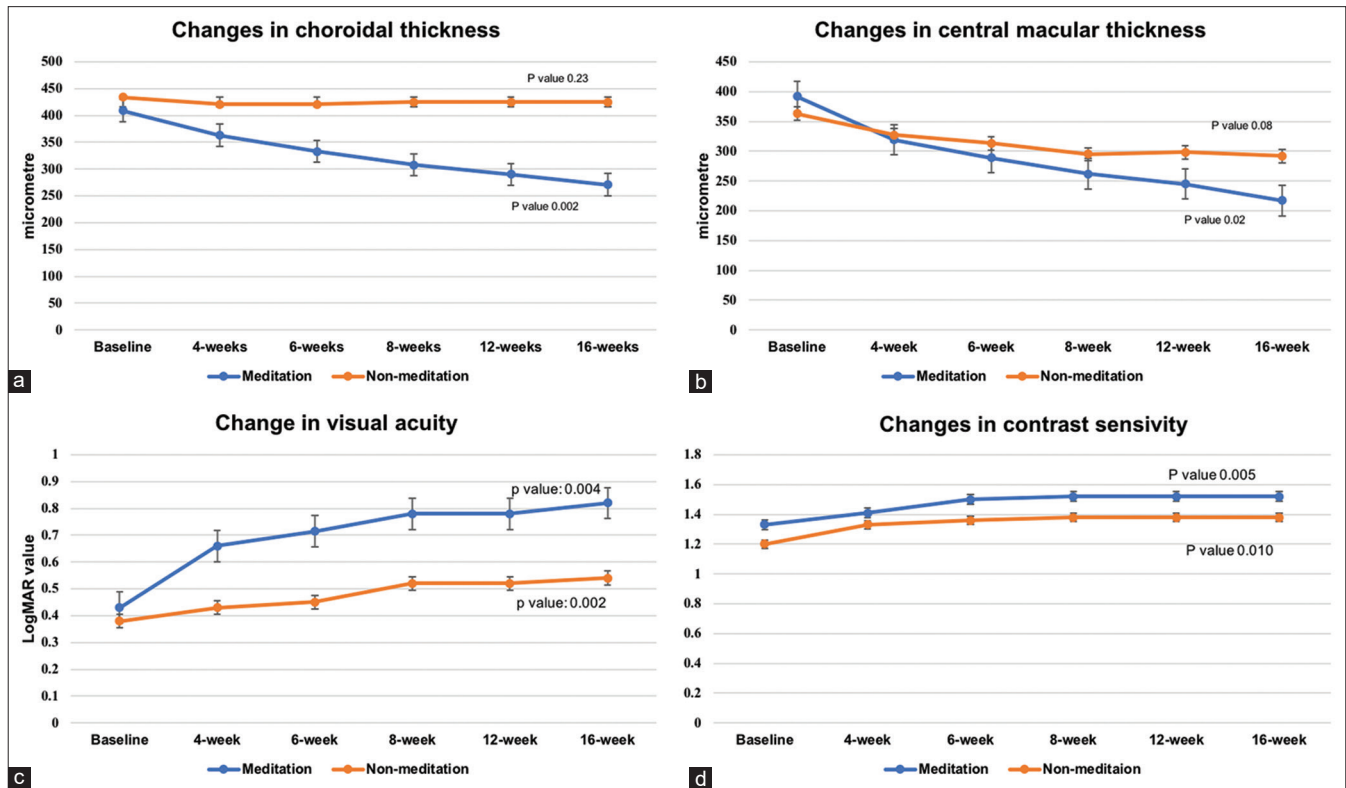


Figure 1: Graphical presentation of various parameters in Group 1 (meditation group) and Group 2 (nonmeditation group). The central macular thickness and choroidal thickness in Group 1 showed a steep decrease at the end of the fourth week with a persistent decreasing trend till the fourth month (a, b). The visual acuity graph of Group 1 showed a steep rise at the end of the fourth week and an increasing trend after 4 weeks (c). The contrast sensitivity in both the groups had improved (d)

Table 2: Parameters at Week 4 and Week 16 of follow-up period

Parameter	Meditation group		P (compared to baseline)	Nonmeditation group		P (compared to baseline)
	Week 4	Week 16		Week 4	Week 16	
Resolution		92%			40%	
STAI Y1	41.65±3	-	0.01	44.1±3.4	-	0.01
STAI Y2	41.6±3	-	0.008	44.2±3.5	-	0.008
SBP	126±11	-	<0.001	129±13	-	0.05
DBP	83.6±7.4	-	0.002	84.8±7.5	-	0.24
CMT	319±30 µm	217±33 µm	0.02	327±84µ	292±92 µm	0.08
CT	363±58 µm	271±52 µm	0.002	421±52 µm	425±58 µm	0.23
VA	0.66±0.35	0.82±0.3	0.004	0.43±0.3	0.54±0.35	0.002
CS	1.41±0.3	1.52±0.2	0.005	1.33±0.2	1.38±0.4	0.010

STAI=State-Trait Anxiety Inventory, SBP=systolic blood pressure, DBP=diastolic blood pressure, CMT=central macular thickness, CT=choroidal thickness, VA=visual acuity, CS=contrast sensitivity

after enrolment. This highlights the lack of motivation and belief in the possible benefits of meditation among the study population and probably the population in general. From our observation in this study, we emphasize that the factors responsible for poor acceptance/compliance need to be first addressed and solved before initiating studies to determine the health benefits of meditation training. Future prospective, randomized, double-blind trials with a large number of participants motivated for meditation training would provide a higher level of evidence to our preliminary observations. Measurement of serological biomarkers of stress, such as endogenous cortisol and catecholamine levels, during the course of such studies, may assist in better understanding the mechanism by which meditation training positively impacts patients with CSC. Despite these limitations, our results suggest that short-term meditation may have beneficial effects in the management of patients with CSC, as it impacts two of its known risk factors – stress and prehypertension.

Conclusion

Short-term meditation therapy had anatomical and functional benefits in patients with CSC. However, the motivation and compliance of patients to meditation training are limiting factors.

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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Conflicts of interest

There are no conflicts of interest.

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SELF-EVALUATION QUESTIONNAIRE STAI Form Y-1

Please provide the following information:

Name _____ Date _____ S _____

Age _____ Gender (Circle) M F T _____

DIRECTIONS:

A number of statements which people have used to describe themselves are given below. Read each statement and then circle the appropriate number to the right of the statement to indicate how you feel *right now*, that is, *at this moment*. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

	NOT AT ALL SOMEWHAT MODERATELY SO VERY MUCH SO
--	---

1. I feel calm..... 1 2 3 4
2. I feel secure 1 2 3 4
3. I am tense 1 2 3 4
4. I feel strained 1 2 3 4
5. I feel at ease 1 2 3 4
6. I feel upset 1 2 3 4
7. I am presently worrying over possible misfortunes 1 2 3 4
8. I feel satisfied 1 2 3 4
9. I feel frightened 1 2 3 4
10. I feel comfortable 1 2 3 4
11. I feel self-confident..... 1 2 3 4
12. I feel nervous 1 2 3 4
13. I am jittery 1 2 3 4
14. I feel indecisive..... 1 2 3 4
15. I am relaxed 1 2 3 4
16. I feel content 1 2 3 4
17. I am worried 1 2 3 4
18. I feel confused..... 1 2 3 4
19. I feel steady..... 1 2 3 4
20. I feel pleasant..... 1 2 3 4

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STAI-AD Test Form Y
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SELF-EVALUATION QUESTIONNAIRE STAI Form Y-2

Name _____ Date _____

DIRECTIONS

A number of statements which people have used to describe themselves are given below. Read each statement and then circle the appropriate number to the right of the statement to indicate how you *generally* feel. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe how you generally feel.

	ALMOST NEVER SOMETIMES OFTEN ALMOST ALWAYS
--	---

21. I feel pleasant..... 1 2 3 4
22. I feel nervous and restless 1 2 3 4
23. I feel satisfied with myself..... 1 2 3 4
24. I wish I could be as happy as others seem to be 1 2 3 4
25. I feel like a failure 1 2 3 4
26. I feel rested 1 2 3 4
27. I am "calm, cool, and collected" 1 2 3 4
28. I feel that difficulties are piling up so that I cannot overcome them..... 1 2 3 4
29. I worry too much over something that really doesn't matter..... 1 2 3 4
30. I am happy 1 2 3 4
31. I have disturbing thoughts 1 2 3 4
32. I lack self-confidence..... 1 2 3 4
33. I feel secure 1 2 3 4
34. I make decisions easily 1 2 3 4
35. I feel inadequate..... 1 2 3 4
36. I am content 1 2 3 4
37. Some unimportant thought runs through my mind and bothers me 1 2 3 4
38. I take disappointments so keenly that I can't put them out of my mind..... 1 2 3 4
39. I am a steady person..... 1 2 3 4
40. I get in a state of tension or turmoil as I think over my recent concerns and interests 1 2 3 4

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STAI-AD Test Form Y
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Figure S1: State-Trait Anxiety Inventory (STAI) – Form Y1 and STAI – Form Y2