

CHAPTER 22

Use of Yoga in Managing Posttraumatic Stress Disorder

Nilkamal Singh, M.Sc.
Shirley Telles, Ph.D.
Acharya Balkrishna

The goal of yoga is to cut the seed of sorrow before it sprouts.

Svāmi Svātmārāma, Hatha Yoga Pradīpikā (fifteenth century)

Individuals who have posttraumatic stress disorder (PTSD) can experience irrational responses, such as intense fear, panic, helplessness, rage, or feeling paralyzed, to seemingly innocuous events. Exposure to traumatic reminders can stimulate stress hormone secretion and influence the activation of brain regions involved in the trauma response. Imaging studies indicate an associated increase in cerebral blood flow in the right medial orbitofrontal cortex, insula, amygdala, and anterior temporal pole and a relative deactivation in the left anterior prefrontal cortex and Broca's area, the expressive speech center (Hull 2002). Hence, when an individual with PTSD is exposed to reminders of the trauma, this exposure may activate brain regions that engender intense emotions (e.g., the amygdala) and simultaneously deactivate brain regions involved in the inhibition of emotions (e.g., prefrontal cortex), sustained attention, working memory, rational thinking, and translation of experience into communicable language. Consequently, traumatized individuals are prone to overreact to reminders of the past by automatically engaging in defensive reactions (fight, flight, freeze, or dissociate) that occurred at the time of the trauma but that are inappropriate reactions to their current reality.

Severe psychological trauma can cause dysfunction in neuroendocrine and autonomic stress response systems, with excessive sympathetic activation, parasympathetic suppression, and increased levels of cortisol. Severe childhood trauma can affect all aspects of development, including cognitive, social, emotional, physical, psychological, and moral development (Harris et al. 2004). Serious consequences of trauma can emerge during adolescence and persist into adult life.

Nonpharmacological therapeutic techniques that enable the person to regulate internal states and responses to stressors can augment psychotherapeutic or pharmacological management of trauma-related disorders (Brown et al. 2009; Saeed et al. 2010). The Indian science of yoga includes physical postures (*asanas*), voluntary regulated breathing (*pranayama*), meditation, conscious sensory withdrawal (*pratyahara*), and philosophical principles (Taimini 1986). Studies have shown that practicing yoga can bring functional and structural changes in brain areas associated with PTSD (Cohen et al. 2009; Hitzel et al. 2010). Even though these studies were completed in healthy individuals, the findings suggest that yoga practice may reduce activity within the amygdala in people with PTSD. Concomitantly, practicing yoga has been shown to activate areas of the brain involved in the inhibition of emotions, as well as to improve sustained attention and working memory (Rajesh et al. 2014; Sheela et al. 2013). Many studies have shown that practicing yoga can be beneficial for depression (Schuwer and Lewis 2016), stress (Fares and Fares 2016), and anxiety (de Manincor et al. 2016). Studies suggest that these effects of yoga may result from restoration of the balance between the functioning of the sympathetic and parasympathetic divisions of the autonomic nervous system. In this chapter, we review randomized controlled studies of the effects of yoga on persons with PTSD diagnoses and discuss possible mechanisms through which yoga can be beneficial in managing PTSD.

Yoga and Posttraumatic Stress Disorder

A search in two bibliographic databases, PubMed and Google Scholar, for “yoga and PTSD” yielded 42 articles, of which we selected 11 for review on the basis of the following criteria: randomized controlled trials (RCTs), use of yoga as the primary intervention, and English language. Review articles and feasibility studies were excluded. Among the 11 RCTs, 4 reported reduction in specific PTSD symptom clusters, including reexperiencing, hyperarousal, and emotional arousal. The remaining 7 found improvement in PTSD-related symptoms (Table 22-1).

In an RCT, 100 adults who had armed combat-related PTSD were randomly assigned to either a Satyananda yoga group or a control group that received the mandatory ordinary assistance protocol designed by the Colombian Agency for Reintegration (Quiñones et al. 2015). After 16 weeks of yoga practice, scores on the Posttraumatic Stress Disorder Checklist–Civilian (PCLC) improved significantly more than scores for the control group ($P < 0.05$); the highest percentage improvement occurred in the reexperiencing symptom cluster in the yoga group ($P < 0.05$) (Quiñones et al. 2015). In an 8-week study, 80 individuals with PTSD symptoms caused by various types of trauma were randomly assigned to a yoga group and a wait-list con-

TABLE 22-1. Summary of randomized controlled studies of yoga for posttraumatic stress disorder (PTSD)

Study	N	Screening tool(s)	Intervention	Duration	Outcomes	Significance
Quiñones et al. (2015)	100	Clinical observation by psychologists	Satyananda yoga	16 weeks	Yoga group: ↓ PCLC; highest percent improvement in reexperiencing	$P < 0.05$ for both groups
Jindani et al. (2015)	80	PCL-17	Kundalini yoga	8 weeks	Yoga group: ↑ improvement in sleep, positive affect, perceived stress, anxiety, stress resilience	$P < 0.05$ for all measures
Culver et al. (2015)	76	PTSD	Yoga	8 weeks	Yoga group: ↓ symptoms of PTSD	$F_{2,28} = 3.30$; $P = 0.05$
Martin et al. (2015)	38	PSS-1 and DSM	Yoga	1/week × 12 weeks or 2/week × 6 weeks	Yoga group: ↓ external motivation	$P < 0.05$
Reddy et al. (2014)	38	PSS-1	Kripalu-based Hatha yoga, trauma sensitive	12 sessions	Yoga group: ↓ AUDIT and DUDIT scores	$P < 0.001$ for both measures
Carier et al. (2013)	31	DSM-IV	Sudarshan Kriya, modified	6 months	Yoga group: CAPS, CES-D, and PCLM-17 improved	CAPS: $P < 0.05$; CES-D: $P < 0.01$; PCLM-17: $P < 0.001$

TABLE 22-1. Summary of randomized controlled studies of yoga for posttraumatic stress disorder (PTSD) (continued)

Study	N	Screening tool(s)	Intervention	Duration	Outcomes	Significance
Seppälä et al. (2014)	21	Screening tool not mentioned	Sudarshan Kriya yoga	7 days	Yoga group: ↓ PTSD scores, anxiety, respiration rate; ↓ startle correlated with ↓ hyperarousal symptoms	PTSD: $P < 0.001$; anxiety: $P < 0.001$; respiration: $P < 0.05$; startle, hyperarousal: $P < 0.001$
Mitchell et al. (2014)	38	PC-PTSD	Kripalu yoga	1/week × 12 weeks or 2/week × 6 weeks	Yoga group: ↓ reexperiencing and hyperarousal symptoms	$P < 0.01$ for both measures
Telles et al. (2010)	22	SQD	Patañjali yoga	1 week	Yoga group: ↓ sadness; control group: ↑ anxiety	$P < 0.05$ for both changes
Catani et al. (2009)	31	DSM-IV	Meditation-relaxation	6 sessions	PTSD ↓ symptoms, ↓ impaired functioning in both groups	$P < 0.001$ for both groups
Gordon et al. (2008)	82	HTQ Trauma symptom list	Mind-body group	6 weeks	Yoga group: ↓ PTSD scores	$P < 0.001$

Note. AUDIT=Alcohol Use Disorder Identification Test; CAPS=Clinician Administered PTSD Scale; CES-D=Center for Epidemiologic Studies Depression Scale; DSM=Diagnostic and Statistical Manual of Mental Disorders; DUDIT=Drug Use Disorder Identification Test; HTQ=Harvard Trauma Questionnaire; PCL-17=Posttraumatic Stress Disorder Checklist; PCLC=Posttraumatic Stress Disorder Checklist-Civilian; PCLM-17=Posttraumatic Stress Disorder Checklist-Military version; PC-PTSD=Primary Care PTSD screen; PSS-I=PTSD Symptom Scale-Interview; SQD=Screening Questionnaire for Disaster Mental Health; ↓=decreased; ↑=increased.

control group (Jundani et al. 2015). Changes in PTSD symptoms were observed in both groups; however, participants in the yoga group showed greater changes in measures of sleep ($P < 0.05$), positive affect ($P < 0.05$), perceived stress ($P < 0.05$), anxiety ($P < 0.05$), stress ($P < 0.05$), and resilience ($P < 0.05$). Approximately 57% of the wait-list control group was involved in other treatments (e.g., cognitive-behavioral therapy or exposure therapy), excluding contemplative components.

Seventy-six orphaned children in Haiti were randomly assigned to a yoga group and an aerobic dance group. An additional nonrandomized wait-list control group was included (Calver et al. 2015). After 8 weeks of intervention, significant improvement in PTSD symptoms was observed in the yoga group ($F_{2,28} = 3.30$; $P = 0.05$); nonsignificant reduction in PTSD symptoms was seen in the aerobic dance group ($P > 0.05$). An RCT of 38 women with PTSD found no change in physical activity or self-efficacy in either a yoga group or an assessment-only control group (Marth et al. 2015). The yoga group had significant reduction in external motivation ($P < 0.05$).

Individuals with PTSD are at high risk for drug and alcohol abuse. In an RCT (Reddy et al. 2014), 38 veteran and civilian women with alcohol and drug use disorders diagnosed with PTSD randomly assigned to a yoga group and a control group. After 12 yoga sessions, scores on the Alcohol Use Disorder Identification Test (AUDIT) and Drug Use Disorder Identification Test (DUDIT) declined significantly in the yoga group ($P < 0.001$). In the control group, AUDIT scores increased, and DUDIT scores remained stable. Hence, for individuals with PTSD, yoga can help increase positive coping strategies and may reduce alcohol and drug abuse.

In an RCT, 31 Australian Vietnam War veterans who were 100% disabled as a result of military service-related PTSD and who failed numerous trials of psychotropic medication combinations and individual and group therapies were randomly assigned to a group that received a 22-hour, 5-day Sudarshan Kriya yoga intervention modified for veterans (followed by home practice and 90-minute follow-up sessions weekly for 6 weeks and then monthly) or to a control group (Carter et al. 2013). After 6 weeks, the intervention group showed significantly greater reductions on the Clinician Administered Posttraumatic Stress Disorder Scale (CAPS) compared with the wait-list control group ($P < 0.05$), with a large effect size of 0.91. At 6-month follow-up, repeat CAPS showed further improvements. Six-week scores on the Center for Epidemiologic Studies Depression Scale (CES-D) and Posttraumatic Stress Disorder Checklist-Military version (PCLM-17) showed significant improvement ($P < 0.01$ and $P < 0.001$, respectively) compared with control participants. In a similar subsequent study, 21 Afghanisthan war veterans were randomly assigned to yoga and wait-list control groups (Seppälä et al. 2014). Sudarshan Kriya yoga was given for 7 days, and follow-up was done at 1 month and 1 year. The yoga group showed reductions in PTSD scores ($P < 0.001$), anxiety symptoms ($P < 0.001$), and respiration rate ($P < 0.05$). A reduction in eyeblink startle reflex was correlated with reductions in symptoms of hyperarousal ($P < 0.001$).

Another study randomly assigned 38 women with PTSD diagnoses to a yoga group and an assessment control (Mitchell et al. 2014). After 12 weeks of Kripalu-based yoga, participants had a reduction in re-experiencing ($P < 0.01$) and hyperarousal ($P < 0.01$). A sample of 22 adult survivors of the 2008 flood in Bihar, India,

were randomly assigned to two groups: a 7-day yoga intervention and a control group who continued their regular activities (Telles et al. 2010). The yoga group showed a significant decrease in sadness ($P < 0.05$). Anxiety significantly increased ($P < 0.05$) in the control group but not in the yoga group, suggesting that yoga might help prevent development of anxiety disorders following mass disasters.

Children (ages 8–14 years) in a refugee camp in Sri Lanka following the 2004 Southeast Asian tsunami were randomly assigned to two groups. One group received six sessions of narrative exposure therapy for children (KIDNET); the other received six sessions of meditation-relaxation (MED-RELAX; Calani et al. 2009). PTSD symptoms and impairment in functioning were significantly reduced at 1 month in both groups and remained stable over time. Follow-up at 6 months showed recovery rates of 81% for the children given KIDNET and 71% for those receiving MED-RELAX. In another RCT, 82 adolescents affected by war in Kosovo who met criteria for PTSD (Harvard Trauma Questionnaire) were randomly assigned to a wait-list control group or a 12-session mind-body group program (meditation, guided imagery, and breathing techniques; self-expression through words, drawings, and movement; autogenic training and biofeedback; and genograms) (Gordon et al. 2008). After 12 sessions, the intervention group had significantly lower PTSD symptoms ($P < 0.001$) compared with the control group. After adolescents in the control group received the same intervention, their symptoms of PTSD diminished.

These randomized controlled studies suggest that yoga can help reduce symptoms of PTSD regardless of the type of the trauma or population. The main limitations of most of the studies were small sample sizes, lack of an active control group, and insufficient details about the specific yoga practices. Unlike pharmaceutical studies, it is virtually impossible to blind subjects to yoga interventions effectively. Because most outcome measures in these studies were psychological tools and because most of the controls were inactive wait-list groups, the psychological effects of participating in a group intervention and interaction with the instructor(s) on the variables measured should be considered. Two of the studies used active control groups (Calani et al. 2009; Culver et al. 2015) and found reductions in PTSD symptoms in both yoga and active control groups. Therefore, although this evidence is promising, it is not conclusive. RCTs with active control groups, physiological measures, and imaging techniques would contribute to understanding the effects of yoga on the brain regions involved in PTSD and its symptomatology.

Possible Mechanisms for Yoga Reduction of Posttraumatic Stress Disorder Symptoms

Given the possibility of using yoga to positively modify mental state following trauma, it is interesting to speculate about the mechanisms underlying the observed benefits. The proposed mechanisms have been presented elsewhere (Telles et al. 2012) and are summarized here.

During a stressful situation, changes in regulation of the serotonin (5-HT) transporter in the amygdala may alter the stress response (Murrugh et al. 2011). The

amygdala of individuals with PTSD shows increased activity. These patients also have abnormally reduced amygdala 5-HT binding, which correlates with higher symptoms of anxiety and depression. Hence, abnormal 5-HT signaling within neural systems possibly underlies threat detection and fear learning. In a case series in which four patients were given 12 weeks of yoga plus slow breathing, single-photon emission computed tomography (baseline and postintervention) found significant decreases in activity in the right amygdala, dorsal medial cortex, and sensorimotor areas (Cohen et al. 2009). Another study found that healthy individuals who participated for 8 weeks in a mindfulness-based stress reduction program showed a decline in amygdala gray matter (Fitzel et al. 2010). These studies support a plausible mechanism whereby yoga could reduce symptoms of PTSD by reducing the overactivation of the amygdala while increasing activity of prefrontal and insular areas.

Studies in which yoga practices increase activity in the “higher” centers, such as prefrontal cortex, insula, and anterior cingulate, suggest that yoga could modulate amygdalar activity. Thus, through direct input to the limbic structures as well as for emotion regulatory systems, yoga could significantly reduce PTSD symptoms. For example, whole blood serotonin levels and mood state changes were assessed before and after focused attention on tandem breathing in 15 healthy right-handed participants (Yu et al. 2011). Tandem breathing, part of Zen meditation, focuses attention on breathing movements in the lower abdomen, with a breath rate of three to four breaths per minute. During focused attention on tandem breathing, participants had a significant increase in oxyhemoglobin level in the anterior prefrontal cortex, an increase in alpha activity with decreased theta activity, and an increase in whole blood serotonin levels that correlated with increased alpha activity and reduced negative feelings.

Imbalance within the ascending dopaminergic tracts may cause rapid fluctuations in the level of arousal and in associated mood, drive, and motivation. Stress reduction, positive affect, and plasma catecholamines were assessed in 67 regular meditators and 57 nonmeditators with a meditation practice called brain wave vibration mind-body training, which is thought to change negative thoughts into positive ones (Jung et al. 2010). Members of the meditation group had higher scores on positive affect and lower scores on negative affect compared with nonmeditators. Their plasma dopamine levels also were higher. The control group showed a negative correlation between stress and positive affect. A positive correlation was also found between somatization of stress and norepinephrine-to-epinephrine and dopamine-to-epinephrine ratios in the control group. Hence, meditation can lower stress levels and increase positive affect and plasma dopamine levels.

The anxiety-lowering effect of yoga practices also may involve the inhibitory neurotransmitter-γ-aminobutyric acid (GABA). Two studies reported that thalamic GABAergic activity increased after yoga practice. In the earlier study, 8 experienced yoga practitioners were compared with 11 nonpractitioners (Streeter et al. 2007). All subjects were evaluated with the Structural Clinical Interview for DSM-IV Axis I Disorders, Research Version, Patient Edition (First et al. 1997), and the Addiction Severity Index. The yoga group completed a 60-minute session that included yoga postures and associated breathing practices, whereas the comparison subjects read periodicals and

popular fiction during a 60-minute session. The GABA levels in the thalamus increased by 27% in the yoga practitioners after the yoga session, but the comparison group showed no change. The second study addressed the issue of whether changes in thalamic GABA levels are specific to yoga or related to physical activity (Streeter et al., 2010). Participants were randomly assigned to a yoga group ($n=19$) or a metabolically matched physical exercise group ($n=15$) for 60 minutes 3 times a week for 12 weeks. Magnetic resonance spectroscopy scans found that thalamic GABA levels increased in the yoga group and were positively correlated with improved mood. Acute changes in GABA levels in the yoga group approached significance ($P=0.09$; t test). Increases in thalamic GABA levels were associated with improved mood and decreased anxiety—changes that usually occur with pharmacological agents for mood and anxiety. These studies suggest that certain changes in neurotransmitters following yoga practice contributed to the improved psychological state in trauma victims who practiced yoga. This is probably one of several ways that yoga can influence psychological state in trauma victims. Studies of changes in neurotransmitter levels in response to yoga in patients with PTSD are needed.

Streeter et al. (2010) hypothesized that stress can induce 1) decreased parasympathetic nervous system (PNS) and increased sympathetic nervous system (SNS) activity, 2) underactivity of the inhibitory neurotransmitter GABA, and 3) increased allostatic load. They further hypothesized that the positive effect of yoga may be the result of 1) increased activity of the PNS and GABA system, partly through stimulation of the vagus nerves, and 2) reduced allostatic load resulting in symptom relief. Conditions such as PTSD are exacerbated by stress, have low PNS and low GABA system activity, respond to pharmacological agents that increase GABAergic activity, and improve in response to yoga-based interventions. In a 12-week Phase I randomized controlled dosing study of 30 patients with moderate major depressive disorder, Beck Depression Inventory-2 scores declined significantly, correlating with increased number of minutes that patients practiced Iyengar yoga and coherent breathing at five breaths per minute (see Chapter 21, "Breathing Techniques in Psychiatric Treatment") ($P=0.02$). In addition, respiratory sinus arrhythmia, a measure of sympathetic and parasympathetic activity, increased significantly ($P=0.03$), indicating increased parasympathetic activity. Moreover, subnormal thalamic GABA levels increased to normal range (Streeter et al., 2016).

KEY POINTS

- The improvement in posttraumatic stress disorder (PTSD) symptoms after yoga practice may be attributed to the following:
 - Increased levels of neurotransmitters such as serotonin, dopamine, and γ -aminobutyric acid
 - Improved regulation of the autonomic nervous system by increasing parasympathetic effects on numerous brain structures involved in stress response and emotion processing

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- Reduction in the hyperactivity of the amygdala, as reflected in reduced PTSD symptoms

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