Yoga as an Adjunctive Treatment for Posttraumatic Stress Disorder: A Randomized Controlled Trial

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ABSTRACT

Background: More than a third of the approximately 10 million women with histories of interpersonal violence in the United States develop posttraumatic stress disorder (PTSD). Currently available treatments for this population have a high rate of incomplete response, in part because problems in affect and impulse regulation are major obstacles to resolving PTSD. This study explored the efficacy of yoga to increase affect tolerance and to decrease PTSD symptomatology.

Method: Sixty-four women with chronic, treatment-resistant PTSD were randomly assigned to either trauma-informed yoga or supportive women's health education, each as a weekly 1-hour class for 10 weeks. Assessments were conducted at pretreatment, midtreatment, and posttreatment and included measures of *DSM-IV* PTSD, affect regulation, and depression. The study ran from 2008 through 2011.

Results: The primary outcome measure was the Clinician-Administered PTSD Scale (CAPS). At the end of the study, 16 of 31 participants (52%) in the yoga group no longer met criteria for PTSD compared to 6 of 29 (21%) in the control group ($n=60$, $\chi^2_1=6.17$, $P=.013$). Both groups exhibited significant decreases on the CAPS, with the decrease falling in the large effect size range for the yoga group ($d=1.07$) and the medium to large effect size decrease for the control group ($d=0.66$). Both the yoga ($b=-9.21$, $t=-2.34$, $P=.02$, $d=-0.37$) and control ($b=-22.12$, $t=-3.39$, $P=.001$, $d=-0.54$) groups exhibited significant decreases from pretreatment to the midtreatment assessment. However, a significant group × quadratic trend interaction ($d=-0.34$) showed that the pattern of change in Davidson Trauma Scale significantly differed across groups. The yoga group exhibited a significant medium effect size linear ($d=-0.52$) trend. In contrast, the control group exhibited only a significant medium effect size quadratic trend ($d=0.46$) but did not exhibit a significant linear trend ($d=-0.29$). Thus, both groups exhibited significant decreases in PTSD symptoms during the first half of treatment, but these improvements were maintained in the yoga group, while the control group relapsed after its initial improvement.

Discussion: Yoga significantly reduced PTSD symptomatology, with effect sizes comparable to well-researched psychotherapeutic and psychopharmacologic approaches. Yoga may improve the functioning of traumatized individuals by helping them to tolerate physical and sensory experiences associated with fear and helplessness and to increase emotional awareness and affect tolerance.

Trial Registration: ClinicalTrials.gov identifier: NCT00839813

J Clin Psychiatry 2014;75(00):e000–e000
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Submitted: *May 2, 2013; accepted November 14, 2013 (doi:10.4088/JCP.13m08561).*
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Approximately 9.8 million adult American women (about 10% of the adult female population) have histories of violent physical assaults, and 12.1 million (12.7%) report having been a victim of completed rapes.[1] More than a third of these traumatic experiences result in the development of posttraumatic stress disorder (PTSD) and are also associated with a range of other comorbid disorders, such as anxiety and depression, as well as physical health problems, including obesity, heart disease, and chronic pain syndromes.[2–7]

Various forms of exposure treatment have been shown to be useful in the treatment of PTSD.[8–11] However, they have a high rate of incomplete response. In a recent large clinical trial[11] of prolonged exposure, 59% of subjects still had PTSD after 12 weeks of treatment, and 78% remained symptomatic at 6-month follow-up. A meta-analytic review[12] of psychosocial treatments for PTSD found that the majority of treatment-seeking populations continue to show substantial residual symptoms and that less than half of patients completing cognitive-behavioral treatment interventions show clinically meaningful improvement. The Institute of Medicine found that the currently available scientific evidence for the treatment for PTSD does not reach the level of certainty that would be desired for such a common and serious condition.[13]

Chronic trauma exposure is associated with significant problems in affect and impulse regulation.[14,15] Becoming flooded or dissociating interferes with the resolution of traumatic memories[16–20] and is associated with high dropout rates or symptom worsening.[16,18,20] The successful extinction of conditioned fear responses, thought to be critical for the resolution of PTSD, requires being able to manage intense emotions and to keep one's attention focused on conditioned stimuli, ie, sensory input emanating from the environment or from within the organism.[16,17,19,21]

Mindfulness meditation, nonjudgmental attention to experiences in the present moment, has been shown to facilitate affect regulation.[21–23] However, traumatized individuals tend to have difficulty tolerating unstructured meditation and do much better with an instructor whose guidance helps them maintain their focus on bodily sensations, while modulating arousal with breathing exercises, as is done in a yoga practice.[24]

It is estimated that yoga is regularly practiced by over 26 million individuals in the United States; it is among the top 10 most widely practiced forms of complementary health care in the United States.[25] Yoga is a comprehensive system of practices that incorporates physical postures, breathing

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Clinical Points

- This study showed that a 10-week, weekly yoga program can significantly reduce posttraumatic stress disorder (PTSD) symptoms in women with chronic treatment-resistant PTSD, compared with a supportive therapy group, with effect sizes comparable to well-researched psychotherapeutic and pharmacologic approaches.
- Current mainstream treatments of PTSD are informed by cognitive and pharmacologic models, as opposed to somatic regulation and interoceptive awareness. However, loss of body awareness, including alexithymia and loss of affect regulation is thought to play a significant role in the pathology of PTSD, which involves changes in physical self-awareness and alterations in the neural structures that register bodily states.
- Body awareness is a necessary aspect of effective emotion regulation. Learning to notice, tolerate, and manage somatic experience may substantially promote emotion regulation. Yoga can serve as a widely available and relatively economical adjunct to the treatment of PTSD.

exercises, and meditation/concentration techniques that have been shown to be associated with changes in autonomic function, muscle strength, blood pressure, heart rate, respiration, plasma cortisol, urinary catecholamines, and improvement in arousal regulation.[26–39]

Yoga has been studied as an effective adjunctive treatment for a large variety of medical disorders, including asthma, heart disease and hypertension, diabetes, chronic pain, arthritis, and insomnia.[27,29,40–45] Other studies also have demonstrated positive effects of yoga on depression and anxiety[46–49] and on acute stress reactions.[50–52]

The physical postures of hatha yoga emphasize flexibility over aerobic fitness. In yoga, the focus of attention is on sensory experiences of breathing and physical sensations. The heightened body awareness fostered by yoga can help to detect physiological aspects of physical sensations (eg, body tension, rapid heartbeat, and short, shallow breath) and provide information about the internal milieu, a prerequisite for accurate identification of the triggered emotional response (ie, fear).[16,21,24,53] The mindfulness aspect of yoga is hypothesized to foster emotion regulation by simply noticing the fear, as opposed to engaging in avoidance. Awareness of the transitory nature of one's momentary experience is thought to lead to a change in the perspective on the self.[53]

The hypotheses of this study were that traumatized women in the yoga condition would show a clinically significant reduction in PTSD symptoms at posttreatment compared with a control group receiving weekly women's health education, as well as demonstrate more improvement on affect regulation measures.

METHOD

Design

Following institutional board review, women 18–58 years old with chronic, treatment nonresponsive PTSD were recruited via newspaper and radio ads, our website, and solicitation from mental health professionals. Trauma history was obtained by self-report. Treatment unresponsiveness was determined by participants having had at least 3 years of prior therapy treatment that focused on the treatment of PTSD. After an initial telephone screening, subjects were assessed, and, if eligible, randomly assigned to either trauma-informed yoga classes or women's health education classes, with each class lasting 1 hour each week for 10 weeks. Participants in the control condition were offered the option of attending 10 weeks of yoga classes free of charge after posttreatment evaluation. The study ran from 2008 through 2011. The study was registered on ClinicalTrials.gov (identifier: NCT00839813).

Participants

A total of 101 participants were assessed at pretreatment after giving written informed consent. Eighty-three participants (82%) met study criteria, and the remainder met study exclusionary criteria, as noted below, or failed to meet the *DSM-IV* diagnostic criteria for PTSD. Of the 83 participants, 7 (7%) withdrew consent prior to randomization and 12 (12%) withdrew consent prior to treatment; 64 (63%) were randomly assigned to treatment and formed the intention-to-treat (ITT) sample. Posttraumatic stress disorder was established based on the Clinician-Administered PTSD Scale (CAPS) F1/I2/Sev65 scoring rules.[54] Chronicity was based on meeting criteria for PTSD in relation to an index trauma that occurred at least 12 years prior to intake. Baseline participant information is contained in Table 1. Comorbid conditions were established with a semistructured interview, the Structured Clinical Interview for *DSM-IV* Axis I Disorders.[55]

Exclusion criteria included unstable medical condition, pregnancy or breastfeeding status, alcohol or substance abuse/dependence in the past 6 months, active suicide risk or life-threatening mutilation, 5 or more prior yoga sessions, and Global Assessment of Functioning (GAF) score < 40. Study participants were required to be engaged in ongoing supportive therapy and to continue whatever pharmacologic treatment they were receiving.

Treatments

The yoga intervention offered 10 weeks of an hour-long trauma-informed yoga class, incorporating the central elements of hatha yoga: breathing, postures, and meditation. The protocolized trauma-informed yoga program[56] was created by certified yoga professionals with master's- and doctoral-level degrees in psychology, with supervision from the principal investigators. Simple, noninterpretive language without metaphors is used. The program emphasizes curiosity about bodily sensations, in which self-inquiry is prominent, with the instructor using key words such as "notice" and "allow," as well as invitational phrases such as "when you are ready" and "if you like." Bodily control is practiced, such as making choices to modify a posture, to stay in a particular posture, or to let the posture go.

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Table 1. Baseline Analysis of Demographic Variables by Treatment Group

Variable	Yoga (n = 32)	Control (n = 32)	Total[a] (N = 64)	*P* Value[b]
Age, mean (SD), y	41.5 (12.2)	44.3 (11.9)	42.9 (12.0)	.35
White race, %	78.1	78.1	78.1	.91
Non-Hispanic ethnicity, %	87.5	84.4	85.9	.67
College graduate, %	75.0	71.9	73.4	.53
Single marital status, %	46.9	43.8	45.3	.65
Employed, %	71.9	46.9	59.4	.05*
Income, $12,000–$15,000, %	18.8	18.8	18.8	.08
CAPS total score, 1 mo, mean (SD)	73.94 (14.4)	76.66 (14.5)	75.3 (14.4)	.46

[a]Total of 2 treatments combined.
[b]Used omnibus analysis of variance for continuous measures or Pearson χ^2 statistic for categorical measures. None were significant except the employment demographic.
*Significant at $P = .05$.
Abbreviations: CAPS = Clinician-Administered PTSD Scale, PTSD = posttraumatic stress disorder.

Women's health education. The control treatment offered 10 weeks of an hour-long women's health education class.[57] The class focused on active participation and support, and utilized an interactive teaching style to increase knowledge about different health areas and increase women's self-efficacy to (1) seek medical services, (2) discuss issues around health with medical professionals, (3) normalize the experience of talking about potentially uncomfortable issues of the body, (4) use medical or body terminology, and (5) conduct and pursue self-care activities (eg, breast self-examination, making food choices). This intervention did not discuss issues related to personal trauma or disclosure of abuse or trauma. Materials included workbooks, resource books, video recordings, informational games, charts, and diagrams. Participants in the control condition, but not in the yoga classes, were allowed to contribute food to the class and to have personal contact outside the class.

Assessments

Both conditions had equal in-person assessment time. Evaluators were postdoctoral- and master's-level clinicians who received extensive training and ongoing supervision in administration of study measures, including interrater reliability on the CAPS, based on coding of live and video-recorded interviews, and were assessed at regular intervals to avoid rater drift. All raters were blind to treatment condition.

Assessments were conducted at pretreatment, midtreatment (week 5), and posttreatment (week 10) and included the CAPS,[54] and self-report measures (Inventory of Altered Self-Capacities,[58] which identifies problems with affect regulation and emotional control; the Davidson Trauma Scale[59]; and the Beck Depression Inventory-II [BDI-II]).[60] Results of the effects of the 2 treatment conditions on physiologic response (heart rate variability) and brain activation (functional magnetic resonance imaging) will be reported separately. Analyses are based on the full analysis set, comprising all participants who were randomized and participated in pretreatment and posttreatment assessments.

Data Analytic Approach

We used hierarchical linear and nonlinear modeling[61] with restricted maximum likelihood estimation to conduct multilevel regression analyses to examine change over time in outcomes as a function of treatment condition.[62] This approach allowed us to analyze the intention-to-treat (ITT) sample without the use of missing data algorithms. Preassessment and postasssessment of PTSD were available for the CAPS, while 3 assessments were available for the Davidson Trauma Scale and BDI. For analyses with 2 assessments, available time was modeled using dummy-coded variables. For analyses with 3 assessments available, time was modeled using linear and quadratic orthogonal polynomial contrasts. For all models, time effects were specified as fixed, producing multilevel models analogous to repeated-measures analyses of variance. To assess treatment effects, a dummy-coded treatment variable was included as a level 2 predictor of change over time. Cohen *d* values are reported as estimates of effect size, and we adopted the convention of $d = 0.25$, 0.50, and 0.80 being indicative of small, medium, and large effect sizes, respectively.

RESULTS

Baseline Group Differences

Participants in the 2 treatment conditions did not differ significantly on any demographic variable (Table 1) or in any baseline measure of psychopathology, with the exception of significance in the employment demographic. Of the yoga group, 71.9% reported being employed versus 46.9% of the control group. However, there were no significant differences on education or family income.

Treatment Dropout

Four people dropped out during the 10-week treatment phase, leaving 60 completers. There were no significant differences in dropout rates between the treatment groups, yoga (n = 1, 1.6%) and control (n = 3, 4.7%). There also were no significant differences between completers and dropouts on any baseline measure of psychopathology.

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Table 2. Outcomes Administered at 2 Assessment Occasions

	Descriptives				Pretreatment-Posttreatment Change		
	Pretreatment		Posttreatment				
Measure	Mean	SD	Mean	SD	*b*	*t*	Cohen *d*
Total CAPS severity							
Yoga	73.94	20.83	49.48	25.16	−24.45***	−5.84	−1.07
Control	76.66	20.83	63.49	25.48	−13.17**	−3.62	−0.66
Group × time					−14.74*	−2.23	−0.41
DES							
Yoga	16.80	9.99	14.11	10.89	−2.68	−1.89	−0.35
Control	18.06	13.65	19.78	14.56	1.72	0.77	0.14
Group × time					−4.40	−1.67	−0.31
IASC-TR							
Yoga	73.66	14.20	67.17	15.32	−6.49*	−2.40	−0.44
Control	67.97	13.81	68.51	17.17	0.54	0.17	0.03
Group × time					−7.03	−1.69	−0.31
IASC-AD							
Yoga	76.69	14.83	68.88	13.31	−7.81**	−3.26	−0.60
Control	75.50	13.49	69.48	14.26	−6.02*	−2.06	−0.38
Group × time					−1.79	−0.48	−0.09

*$P < .05$.
**$P < .01$.
***$P < .001$.
Abbreviations: *b* = unstandardized regression coefficient, CAPS = Clinician-Administered PTSD Scale, DES = Dissociative Experiences Scale, IASC-AD = Inventory of Altered Self-Capacities–affect dysregulation scale, IASC-TR = Inventory of Altered Self-Capacities–tension reduction subscale.

Table 3. Outcomes Administered at 3 Assessment Occasions

	Descriptives						Change Parameters					
	Pretreatment		Midtreatment		Posttreatment		Linear Change			Quadratic Change		
Measure	Mean	SD	Mean	SD	Mean	SD	*b*	*t*	*d*	*b*	*t*	*d*
DTS												
Yoga	65.17	23.50	56.01	26.59	51.49	24.09	−6.84**	−3.25	−0.52	0.79	0.66	0.11
Control	73.06	25.86	50.96	24.91	63.75	28.81	−4.66	−1.82	−0.29	5.82*	2.86	0.46
Group × time							−5.07	−0.86	−0.10	−5.03*	−2.13	−0.34
BDI-II												
Yoga	20.89	11.13	19.23	13.59	13.92	9.91	−3.49***	−3.77	−0.60	−0.57	−1.20	−0.19
Control	24.06	11.47	19.51	11.65	19.47	11.91	−2.29*	−2.44	−0.39	0.78	1.28	0.20
Group × time							−3.02	−1.07	−0.14	−1.34	−1.75	−0.28

*$P < .05$.
**$P < .01$.
***$P < .001$.
Abbreviations: *b* = unstandardized regression coefficient, BDI-II = Beck Depression Inventory-II, DTS = Davidson Trauma Scale.

Results

Results are presented on loss of PTSD diagnostic status using the CAPS < 45 scoring rule, determined to be the most effective to rule out false negatives (Tables 2 and 3). Prior to conducting the hierarchical linear and nonlinear modeling analyses, a χ^2 test was conducted to examine the proportion of participants meeting PTSD diagnostic criteria as measured by the CAPS at the final assessment and whether this proportion varied as a function of group. Sixteen of 31 participants (52%) in the yoga group who completed the CAPS at the final assessment no longer met criteria for PTSD compared to 6 of 29 (21%) who no longer met criteria in the control group (n = 60, $\chi^2_1 = 6.17$, $P = .013$).

The results of the change over time analyses are depicted in Tables 2 and 3. Both groups exhibited significant decreases on the CAPS, with the decrease falling in the large effect size range for the yoga group ($d = 1.07$) and the medium to large effect size decrease for the control group ($d = 0.66$). A significant time × group interaction indicated that the yoga group exhibited larger decreases on the CAPS than the control group, with this difference approaching a medium effect size ($d = -0.41$).

The 2 groups exhibited a different pattern of change on the Davidson Trauma Scale (Figure 1). Both the yoga ($b = -9.21$; $t = -2.34$; $P = .02$; $d = -0.37$) and control ($b = -22.12$; $t = -3.39$; $P = .001$; $d = -0.54$) groups exhibited significant decreases from pretreatment to the midtreatment assessment. A significant group × quadratic trend interaction ($d = -0.34$) indicated that the pattern of change in Davidson Trauma Scale significantly differed across groups. The yoga group exhibited a significant medium effect size linear trend ($d = -0.52$). In contrast, the control group exhibited only a significant medium effect size quadratic trend ($d = 0.46$) but did not exhibit a significant linear trend ($d = -0.29$). Thus, both groups exhibited significant decreases in PTSD symptoms during the first half of treatment, but, in the yoga

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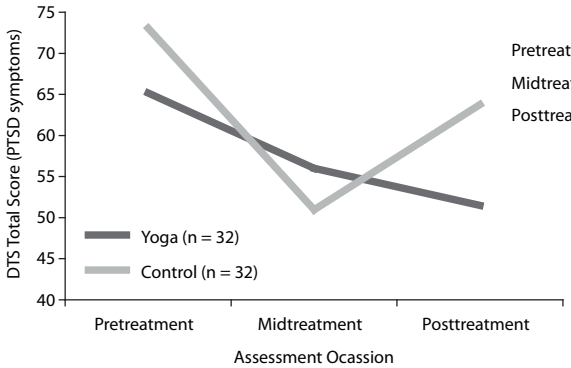
Figure 1. Change in Davidson Trauma Scale (DTS) as a Function of Group



	Yoga	Control
Pretreatment	65.17	73.06
Midtreatment	56.01	50.96
Posttreatment	51.49	63.75

Abbreviation: PTSD = posttraumatic stress disorder.

group, these improvements were maintained, while the control group relapsed after the initial improvement.

Both groups exhibited improvements on several of the supplemental outcome measures (see Tables 2 and 3). For instance, both groups showed significant decreases in BDI scores (as indicated by statistically significant linear trends), with the yoga group showing a medium effect size decrease ($d = -0.60$) and the control condition exhibiting a small-medium effect size decrease ($d = -0.39$); however, the difference between the 2 groups was not statistically significant. While the group × time interactions generally did not approach statistical significance, there was some evidence supporting an advantage of yoga over the control condition. For example, the yoga condition revealed a significant decrease on the tension reduction subscale of the Inventory of Altered Self-Capacities, approaching a medium effect size ($d = -0.44$), while change over time on this subscale did not approach statistical significance for the control condition ($d = 0.03$). The group × time interaction for the Inventory of Altered Self-Capacities–tension reduction subscale approached statistical significance ($P = .09$), with an effect size estimate ($d = -0.31$) falling directly in the middle of small and medium suggested cutoffs.

DISCUSSION

This study showed that a 10-week weekly yoga program compared with supportive therapy can significantly reduce PTSD symptomatology in women with chronic treatment-resistant PTSD, with effect sizes comparable to well-researched psychotherapeutic and pharmacologic approaches. In contrast, after an initial positive response, the control group reverted to baseline. Depression scores of both groups declined significantly and, in the control group, continued to improve, even as their PTSD scores relapsed. The supportive nature of the control group, which encouraged the sharing of food and maintenance of contact outside of formal sessions, may have significantly improved the mood of this group, but it did not produce a sustained reduction in PTSD symptomatology. This suggests that the physical and interoceptive aspects of yoga, rather than the social dimensions of the groups, were the critical variables responsible for the change in PTSD symptomatology.

The identification of supplementary treatments for PTSD is important because many individuals with chronic PTSD tolerate exposure treatments poorly[17–20] and because conventional PTSD treatments are not available to many traumatized individuals.

Current treatments for PTSD are informed by cognitive and pharmacologic models, as opposed to somatic regulation and interoceptive awareness. Body awareness has been shown to be central for consciousness and emotion regulation.[63–66] Knowing how one feels depends on brain regions involved in the registration of internal homeostasis.[22,64–66] Loss of body awareness, including alexithymia, and loss of affect regulation are thought to play a significant role in the pathology of PTSD, which has been shown to involve changes in physical self-awareness and in alterations in the neural structures that register bodily states.[16,63] Learning to notice, tolerate, manage, and reinterpret visceral sensations may substantially promote affect tolerance.

Yoga has 3 principal components: breathing exercises (pranayama), postures (asanas), and mindfulness meditation. Each 1 of these has been shown to affect neurobiological functioning.[16] Changing breathing patterns can influence autonomic nervous system functions, including heart rate variability and cardiac vagal tone.[23,26,30,31] The extensive research on the effects of mindfulness meditation has been demonstrated to positively influence numerous psychiatric, psychosomatic, and stress-related symptoms, including anxiety, depression, chronic pain, immune function, blood pressure, cortisol levels, and telomerase activity.[22–24,53] Of the 3 principal components of yoga, the various poses (asanas) have been least studied. However, yoga poses are likely to help individuals to observe and tolerate physical sensations and to use this tolerance to disconnect their physical feelings from the emotional reactions to assaults in the past.

Limitations

This study included only treatment-resistant adult women with chronic PTSD secondary to interpersonal

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assaults that started in childhood. They had major comorbid problems with depression, anxiety, and affect regulation. All participants lived in the United States and were relatively well educated. Significantly more participants in the yoga group were employed than in the control group. However, their education and family income did not differ significantly. Clearly, our results need to be replicated with younger, less educated, and more acutely traumatized populations of both genders, in a variety of cultural settings

This study lasted only 10 weeks, without formal follow-up, while yoga usually is practiced for prolonged periods of time, just as psychotropic medications have a longer period of administration. While the mechanisms of mindfulness meditation are being widely investigated, this effort has not yet been extended to yoga. Yoga is a complex combination of breathing, postures, and mindfulness practice. Future research needs to dismantle these components and study the specific contributions of each of them.

Future Directions

The well-documented lack of affect modulation in many traumatized individuals invites the exploration of mindfulness and other self-management techniques to deal with the modulation of arousal and attention. Learning to actively modulate one's physiological arousal has the potential of decreasing the cost of service delivery and to positively affect the dependence of traumatized individuals on mental health delivery systems.

If traumatized individuals can learn to identify and tolerate physical sensations, they are likely to increase emotional awareness and affect tolerance. The possibility of posttrauma recovery by altering body awareness has the potential of decreasing physical comorbidities in traumatized individuals, decreasing health care utilization, and increasing the capacity to tolerate and utilize bodily signals for detecting danger and discomfort, thereby opening the possibility of decreasing the high rate of revictimization in this chronically traumatized population.[4]

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Potential conflicts of interest: None reported.
Funding/support: This study was supported by Grant 1R21AT003905-01A2 from the United States National Center for Complementary and Alternative Medicine (NCCAM).
Role of the sponsor: The NCCAM paid for all salaries, subject payments, and supplies for this study.
Previous presentation: These data have been previously presented at the 26th Annual Meeting of the International Society for Traumatic Stress Studies; November 3–5, 2011; Baltimore, Maryland.
Acknowledgments: The authors acknowledge Ritu Sharma (PhD), Psychological Counseling Services, Boston University; Jen Turner (MA) (yoga teacher), Jessica Shore (MA) (assessment), Marla Zucker (PhD) (recruitment), Mark Gapen (PhD) (data entry), Hilary Hogdon (PhD) (data entry), Regina Musicaro (MA) (recruitment and assessment), and Ilya Yacevich (MSW) (recruitment and assessment), Trauma Center, Brookline, Massachusetts; and Sat Bir Khalsa (PhD) (research design), Harvard University School of Medicine, Cambridge, Massachusetts. None of the acknowledged individuals have any conflicts of interest to report.

Case Vignette

The potential benefit of yoga to establish physical awareness and self-care is illustrated by Ms A, a 55-year-old, married primary school teacher with a history of severe physical and sexual abuse and multiple hospitalizations for self-injurious behavior, depression, and suicidality. She spontaneously sent the principal investigator an e-mail in which she described her yoga experiences: "Yoga is about looking inward, instead of outward, and listening to my body. A lot of my survival has been geared around never doing those things . . . I have been refusing to listen to my body, which is such an important part of who I am. I am so disconnected from my body when I cut it. In the yoga class, I was able to move my body and be in my body without hurting myself or getting hurt."

Body awareness may confer an increased sense of control, which positively impacts self-regulation. Ms A went on to say, "I tried just noticing the sensations in my body in class. I slowly learned to just have my feelings, without being hijacked by them. I am more present in the moment. I am more tolerant of physical touch. I finally can feel intimate with my husband."

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