Yoga in Stroke Rehabilitation: A Systematic Review and Results of a Pilot Study

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Purpose: This article presents a systematic review of the literature pertaining to the use of yoga in stroke rehabilitation. In addition, we present the results of a small pilot study designed to explore the hypothesis that a Kundalini yoga practice of 12 weeks would lead to an improvement in aphasia as well as in fine motor coordination in stroke patients. **Method:** The 3 participants attended yoga classes twice a week for 12 weeks, before and after which they were tested on the O'Connor Tweezer Dexterity test, a timed test where the participant places pins in a Peg-Board with tweezers, and the Boston Aphasia Exam for speech. **Results:** All 3 participants showed improvement on both measures. **Conclusion:** The small sample size makes it impossible to draw definite conclusions, but the positive trends in this study suggest that further research should be done to examine the effects of Kundalini yoga on specific illnesses or medical conditions. **Key words:** *aphasia, Kundalini, stroke, yoga*

Yoga is a philosophical system that originated in India approximately 4,000 years ago, and it was primarily intended as a means toward increasing self-awareness. The first written references to yoga postures date back to the Upanishads of the 6th century BC. Many forms of yoga exist, including Hatha yoga, the most popular form in the west, and Kundalini yoga (as taught by Yogi Bhajan), which was utilized in this study. Both forms have the goal of improving the health and functioning of the body and mind, but they differ in structure and specific practices. Kundalini yoga's focus on *kriyas* differentiates it from Hatha yoga, which is organized around *asanas*, physical postures, most of which are held for a specific period of time. A *kriya* is a specific combination of yoga exercises utilizing breath (pranayama), postures (asana), rhythm, sound (mantra), hand postures (mudras), and visual focus (drashti). These exercises are practiced in sequence and for given time periods. *Kriyas* are intended to instigate a change in a particular part of the body or mind and reestablish homeostasis. There are sets for right-brain and left-brain coordination, as well as sets that are meant to restore balance to the nervous system. In addition to these bodily areas, *kriyas* exist for the pituitary gland, lymphatic system, for elimination and circulation, for the heart center, as well as for many other body systems. These *kriyas* and other Kundalini yoga techniques, therefore, can be used to regulate the glandular system, strengthen and relax the nervous system, enhance the cardiovascular system, and create a total feeling of wellness both mentally and physically. We chose to use Kundalini yoga in this study because it is a targeted and specific form of yoga, whose effects can be seen within a short period of time.

To date, there are very few well-controlled studies on yoga for stroke rehabilitation and none that focus on Kundalini yoga specifically. Consequently, the following literature review includes other forms of yoga in addition to Kundalini yoga.

Systematic Review: Method

Using the search terms "yoga," "cerebrovascular accident," yoga (textword), stroke (textword), "cardiovascular physiology," "cerebrovascular disorders," and "hypertension," we searched the following databases for relevant published material:

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Top Stroke Rehabil 2007;14(4):1–8

www.thomasland.com

doi: 10.1310/tsr1404-1

- MEDLINE 1966–2005
- CINAHL 1982–2005
- CDSR (Cochrane Databases of Systematic Reviews)
- DARE (Database of Abstracts of Reviews of Effects)
- ACP Journal Club
- Cochrane Central Register of Controlled Trials
- PsycInfo 1806–2005
- Embase 1980–2005; 1974–1979
- MANTIS (Manual, Alternative and Natural Therapy)
- AMED (Allied and Complementary Medicine)
- SPORTDiscus 1830–2005
- Google Scholar

We also hand-searched the bibliographies of relevant articles and the paper files in our department library for additional sources.

This search yielded no controlled trials of yoga for stroke rehabilitation. There was one recent small case series and three case reports on complications, which are discussed below. There are numerous studies of the effect of yoga interventions on hypertension and cardiovascular physiology, which may have a relevance in prevention of stroke.[1–5] These articles, however, are outside the scope of this review.

Although these studies were not included in the systematic review, we also include discussion of the literature on the impact of yoga on dexterity, cognitive performance, and depression in healthy subjects, as all of these have a bearing on the possible role of yoga in stroke rehabilitation. This literature is summarized in the discussion of our pilot trial.

Systematic Review: Results

The single published study to date examining the effectiveness of yoga in poststroke rehabilitation focused on the effect on improving poststroke hemiparesis.[6] Bastille and Gill-Body examined the effects of a yoga-based therapy invention on balance and mobility in four stroke patients, all at a plateau of recovery at least 9 months poststroke. The small number of participants did not allow for statistical analysis on the significance of the findings; thus the authors chose to report the findings in a single-subject, before and after study design. The investigators report improvement on the Berg Balance Score in two of the participants following the intervention and improvement on the Timed Movement Battery in three of the participants, with the measure of improvement being a change of at least two standard deviations from the baseline in each patient. This study utilized an 8-week intervention involving two 1.5-hour sessions of Hatha yoga weekly in the participant's home. The small size of the study makes these findings hypothesis-generating only, but the results suggest that further study would be useful.

In one of the case reports on yoga and stroke, the authors describe a basilar artery occlusion occurring in a 34-year-old woman 2 months following a headstand yoga position.[7] This patient began to experience symptoms of neck pain and right-hand numbness immediately following a headstand posture but was not diagnosed with the vertebrobasilar occlusion until 2 months later, so conclusions regarding cause and effect are difficult. Two other cases of vertebral artery occlusion following yoga exercises have been reported, one in a 25-year-old and one in a 28-year-old.[8,9]

In summary, our literature review found very little published material on the impact of yoga as part of stroke rehabilitation. Given that many rehabilitation programs currently offer yoga as an option to patients, and that yoga is included as a therapeutic option in a number of rehabilitation medicine texts,[10–12] this lack of published studies is somewhat surprising and needs to be addressed.

Pilot Study: Method

In our small exploratory pilot study, we were interested in determining whether a Kundalini yoga practice of 12 weeks would lead to an improvement in aphasia as well as in fine motor coordination in stroke patients. Our purpose was to determine if the change in outcome following the intervention was significant enough to justify the conduct of a larger, controlled clinical trial. Participants were stroke patients diagnosed with aphasia who were at least 6 months poststroke. They were recruited from the outpatient rehabilitation units, acute care stroke units, and the stroke support group at Beth Israel Medical Center, New York. We enrolled three participants who partici-

Table 1. Auditory comprehension

	Word discrimination			Body part identification			Commands			Complex ideational material		
Patient	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change
Subject 1	70/72	72/72	+10%	20/20	20/20	0%	15/15	15/15	0%	12/12	12/12	0%
Subject 2	72/72	72/72	0%	20/20	20/20	0%	15/15	15/15	0%	12/12	12/12	0%
Subject 3	70/72	70/72	0%	20/20	20/20	0%	14/15	14/15	0%	12/12	12/12	0%

Note: Pre = pretreatment, October 2002; post = posttreatment, December 2003.

pated for the entire 12-week course of yoga classes.

Stroke patients were asked to participate in a Kundalini yoga program that had been designed specifically to benefit their medical condition. They then participated in 12 weeks of yoga classes. Classes were given twice a week, for a total of 24 classes. Each class lasted for 1.5 hours. During the yoga class, a certified yoga instructor led participants through a series of exercises that were specifically chosen to benefit individuals with aphasia. The same *kriya* (combination of yoga exercises) and meditation were repeated in each class. The instructor was given the freedom to determine if any of the exercises were inappropriate for any of the participants to perform and to adjust the difficulty of any of these exercises if necessary. Participants could also decline to assume any position that they found uncomfortable during class. In addition to physical exercises, the instructor led the class in meditation for approximately 11 minutes, using a spoken mantra, which is a series of words or sounds. Two mantra meditations – Sat Kriya and a Gaitri Mantra (Ra Ma Da Sa Sa Say So Hung) – were used, and the mantras were repeated each class. If a participant could not speak the mantra, he/she was asked to concentrate on the sounds of the mantra as it was spoken in his/her presence.

Prior to beginning the yoga classes and also at the end of the 12-week period, participants were given the Boston Diagnostic Aphasia Exam[13] by a speech therapist, along with the O'Connor Tweezer Dexterity Test[14] of fine motor dexterity. The Boston Diagnostic Aphasia Exam is a standardized evaluation performed by a speech therapist that examines the patient's reading, writing, and expressive language skills. The O'Connor Tweezer Dexterity Test is a timed test in which the patient uses tweezers to place pins into small holes on a Peg-Board. The Boston Diagnostic Aphasia Exam was chosen as the most comprehensive and reliable exam used for evaluating the severity of a patient's aphasia. The O'Connor Tweezer Dexterity Test was chosen after evaluating the possibility of using other widely used physical therapy tests, the FIM™*, Fugl-Meyer, and the Barthel Index. The Tweezer Dexterity Text is standardized, is widely used by physical therapists to test fine motor control, and is difficult to perform. Participants also completed the SF-36®,[15] a standardized measure of quality of life and functioning.

Pilot Study: Results

Because of the very small sample, we were looking for general trends that would indicate that further research was warranted, but we did not expect to find statistical significance at the conventional alpha level of .05. Thus we did not perform any statistical analysis on the group as a whole. We chose rather to present the before and after intervention results for each participant in table format.

The O'Connor Tweezer Dexterity Test yielded 2 outcome values, while the speech evaluation yielded 25 outcomes based on raw data (not normative percentiles). The outcome measure on the dexterity test is time in seconds to fill all the holes on the Peg-Board. The measure was repeated with the right and left hand. Results for each patient on the speech outcome measures are presented in **Tables 1** through **5** and on the dexterity outcome measure in **Table 6**.

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Table 2. Verbal expression

	Automatized sequence			Word repetition			High probability phrase repetition			Low probability phrase repetition		
Patient	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change
Subject 1	8/8	8/8	0%	8/10	9/10	+10%	5/8	6/8	12.5%	2/8	6/8	50%
Subject 2	8/8	8/8	0%	10/10	10/10	0%	8/8	8/8	0%	8/8	8/8	0%
Subject 3	8/8	8/8	0%	8/10	8/10	0%	0/8	4/8	50%	1/8	1/8	0%

Note: Pre = pretreatment, October 2002; post = posttreatment, December 2003.

Table 3. Oral agility

	Nonverbal agility			Verbal agility		
Patient	Pre	Post	% change	Pre	Post	% change
Subject 1	10/12	10/12	0%	14/14	14/14	0%
Subject 2	12/12	12/12	0%	10/14	13/14	21.42%
Subject 3	8/12	10/12	16.67%	8/14	9/14	7.14%

Note: Pre = pretreatment, October 2002; post = posttreatment, December 2003.

Table 4. Reading comprehension

	Symbol and word discrimination			Word recognition			Comprehension and oral spelling			Word-picture matching			Reading sentences and paragraphs		
Patient	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change
Subject 1	10/10	10/10	0%	8/8	8/8	0%	7/8	8/8	12.5%	10/10	10/10	0%	9/10	10/10	10%
Subject 2	10/10	10/10	0%	8/8	8/8	0%	8/8	8/8	0%	10/10	10/10	0%	9/10	10/10	10%
Subject 3	10/10	10/10	0%	7/8	8/8	12.5%	2/8	4/8	25%	10/10	10/10	0%	4/10	7/10	30%

Note: Pre = pretreatment, October 2002; post = posttreatment, December 2003.

Table 5. Written language

	Spelling and dictation			Written confrontation naming			Written expression		
Patient	Pre	Post	% change	Pre	Post	% change	Pre	Post	% change
Subject 1	9/10	10/10	10%	9/10	10/10	10%	5/5	5/5	0%
Subject 2	9/10	10/10	10%	10/10	10/10	0%	4/5	4/5	0%
Subject 3	0/10	2/10	20%	0/10	3/10	30%	0/5	0/5	0%

Note: Pre = pretreatment, October 2002; post = posttreatment, December 2003.

Table 2. Continued

Responsive naming			Confrontational naming			Boston naming test		
Pre	Post	% change	Pre	Post	% change	Pre	Post	% change
30/30	30/30	0%	114/114	114/114	0%	45/60	54/60	15%
30/30	30/30	0%	114/114	114/114	0%	52/60	56/60	6.67%
29/30	26/30	−20%	103/114	98/114	4.39%	–	–	–

Subject 1: J.K.

J.K. is a 68-year-old male, born March 10, 1939, admitted for ischemic stroke on December 20, 2000. Prior to this event, he had had two possible transient ischemic attacks (TIAs) earlier in the same year; both of these events involved aphasia, and the second also had a motor component. His medical history prior to his cerebrovascular event was significant only for supraventricular tachycardia.

At the time of his stroke, J.K. did not go to the hospital immediately as a consequence of mental confusion. He was unable to speak properly and had a right-sided hemiparesis. He was admitted to hospital and discharged 8 days later. Following his discharge, J.K. underwent physical therapy and speech therapy for approximately 6 months and was started on Coumadin and a beta-blocker. J.K. has been married and divorced twice and is currently single. He has one son, who lives in Phoenix, and two grandchildren. He worked as a teacher in New York public schools and then as a consultant in communication. He has retired since his stroke, although he reports that he would like to resume working. His hobbies include running, step classes, and attending concerts.

At the time of entry in the study, speech evaluation showed "a mild fluent aphasia with some word-finding difficulty and phonemic paraphasic errors," with an Aphasia Severity Rating (ASR) of 4, which indicates "obvious loss of fluency in speech without significant limitation on ideas expressed or form of expression." He also reported at that time being "very limited" in vigorous activities such as running and strenuous sports. J.K. also reported at that time that he "walks differently" with his right foot than with his left, although this was not noticeable to others.

Subjectively, J.K. experienced improvement in his aphasia following the intervention, although he still reports some difficulty, especially early in the day, which improves as the day progresses. His ASR following the intervention remained at 4, but the evaluator described "an improvement in all areas of language…with a reduction in the amount of phonemic paraphasias and word-finding difficulty."

As seen in **Table 6**, J.K.'s dexterity improved by 47% on the right side and 29% on the left side following the yoga intervention. He remains unable to touch type, which he could do before his stroke. However he now describes himself as "not limited at all" in running or vigorous sports. He continues to attend yoga class twice weekly

Subject 2: R.W.

R.W. is a 75-year-old male, born January 28, 1932, admitted in October 1999 for an ischemic stroke. His medical history prior to this point was significant only for hypertension. R.W. presented with sudden onset of aphasia, with no motor findings. He was hospitalized for 1 week at that time and discharged on Coumadin. Subsequently he was found to have atrial fibrillation and started on Cardizem as well. Following his stroke, he had speech therapy for approximately 4 months. R.W. is married and has two children and two grandchildren. He continues to work part-time as an attorney. His hobbies prior to his stoke included sailing and astronomy. At the time of study entry, R.W. showed a significant loss of fluency, with an ASR of 4.

Following the intervention, the ASR score improved to 5, indicating "minimal discernible speech handicaps." The evaluator described him as having a "mild expressive aphasia" in his follow-up

Table 6. Tweezer Dexterity Test

	Right hand			
Patient	**Pre**	**Post**	**Time difference**	**% change**
Subject 1	9 min. 45 sec	8 min. 35 sec.	1 min. 10 sec.	+12%
Subject 2	14 min. 34 sec.	7 min. 44 sec	6 min. 50 sec.	+47%
Subject 3	17 min. 42 sec.	11 min. 44 sec.	5 min. 58 sec.	+33.7%
	Left hand			
Patient	**Pre**	**Post**	**Time difference**	**% change**
Subject 1	14 min. 42 sec.	12 min. 20 sec.	2 min. 22 sec.	+16%
Subject 2	10 min. 36 sec.	7 min. 31 sec.	3 min. 5 sec.	+29%
Subject 3	8 min. 13 sec.	6 min. 48 sec.	1 min. 25 sec.	+17%

Note: Pre = pretreatment, October 2002; post = posttreatment, December 2003.

evaluation, with "dysfluency no longer evident in his spontaneous speech." Subjectively R.W. reports that he still experiences more difficulty in understanding things, particularly in a noisy setting or when multiple people are speaking at once. He also has trouble when at the theater, as he finds it difficult to understand people speaking from a distance. He still describes his speech as "faulty" at times and feels frustrated by this.

On the dexterity measure, R.W. demonstrated an improvement of 12% on the right side and 16% on the left side. He continues to practice yoga, sometimes daily and at other times one or twice weekly. He also walks and swims for exercise. He reports occasional depression but otherwise feels well.

Subject 3: C.H.

C.H. is a 63-year-old female, born in 1944, who was admitted for a stroke in March 1993. At the time of the stroke, she was unable to say her name and experienced significant right paresis of arm and leg. She had no significant medical history and has had no subsequent cerebrovascular events. C.H. spent 4 weeks in the hospital at that time, followed by several months of outpatient physical therapy and speech therapy. The cerebrovascular event affected her right leg, but she was able to walk at the time she left the hospital.

C.H. was married at the time of her stroke but is now separated. She has two children, a daughter born in 1974 and a son born in 1976. Her children live in Seattle, and she has no grandchildren. C.H. worked as a lactation consultant prior to her stroke; following her hospitalization, she found the work difficult but has continued on a part-time basis. Hobbies include cooking and gardening; she finds reading difficult since her stroke.

At study entry, C.H. had an ASR of 4, with "word-finding difficulties and dysfluencies." Although individual measures showed some improvement (see **Tables 1–5**) her ASR remained at 4 following the intervention, and the evaluator described continuing issues with word-finding difficulty, impaired repetition, and impaired speech rhythm. Subjectively, C.H. continues to find telephone conversations difficult and finds that writing is also difficult, although copying is not a problem. On the dexterity measure, C.H. demonstrated an improvement of 34% on the right side and 17% on the left side. C.H. continues to do a yoga breathing practice at least once weekly at this point, finding that it helps her with "focusing."

Pilot Study: Discussion

Our hypothesis in this pilot study—that yoga training would have an impact on dexterity and on aphasia in patients with stroke—was based on the results of a number of earlier studies examining the impact of yoga training on cognitive function and dexterity in healthy participants. Recent studies in healthy adults have shown yoga training to have a

positive effect on cognitive functioning, particularly in the areas of reaction time and strategic planning. Manjunath and Telles[16] found that, following a yoga intervention, both planning time and execution time were significantly reduced on the Tower of London task test, a measure of planning ability in which participants are asked to preplan mentally a series of moves of a set of beads mounted to rods that will match a goal arrangement and then execute the moves one by one. The participants practiced yoga postures (*asanas*), regulated breathing (*pranayama*), yoga cleansing practices (*kriyas*), and meditation for 1.25 hours a day, 7 days a week, for 1 month during the study. Another study[17] found improved performance on maze learning from baseline compared to a retest after 30 days of a yoga practice. Participants received 30 days of extensive yoga training, including yoga postures (*asanas*), regulated breathing (*pranayama*), and yoga cleansing practices (*kriyas*) in addition to meditation and yoga theory as part of this intervention.

Additional studies have shown improvement in fine motor coordination and auditory and visual reaction time after yoga training. These studies focus on voluntary responses that are linked to cognitive functioning. One such study, which utilized the O'Connor Tweezer Dexterity Test,[18] examined two groups of patients: one group who volunteered to study the yoga and another group who was required to take the training as part of their job. Both groups participated in the same yoga program as in the maze-learning study cited earlier. These authors found that the group who volunteered for yoga had a significant improvement in the performance on the test, whereas there was only slight change in performance by the forced group and none for non-yoga groups. These results were consistent across age and gender, and they raise an interesting question of how much influence motivation has on the effectiveness of the yoga training.

A final study[19] showed a decrease in auditory and visual reaction time in two groups of healthy males, one of whom practiced Hatha yoga and *pranayama* for only 1 hour and the other who practiced for 1 hour daily for 6 weeks. Both groups showed a reduction in reaction time, with the group who practiced for 6 weeks showing a more significant result. This finding supports the belief that yoga is more beneficial to the individual the longer the commitment to the practice.

Yoga has also been shown to be beneficial in at least one study of depression in otherwise healthy adults.[20] Because depression is so prevalent among patients recovering from stroke, and because it can have a huge impact on motor and cognitive functioning, this finding may be relevant to its application in patients following a stroke.

As is clear from the literature review, there is very little research to date on yoga and stroke rehabilitation. Our small study was designed not to provide definitive evidence of yoga's efficacy in stroke rehabilitation, but rather to point to potential applications for further study. Our study examined two areas: physical changes in the form of improved motor coordination, and cognitive changes in the form of improvement of speech impairments.

All three patients showed substantial improvement on our dexterity outcome measure during the course of the study. All three of our participants also showed improvement in their speech, with a reduction in their aphasia—although not necessarily with a change in the overall ASR. Although we did see improvement on 15 of the 25 possible outcome measures, the small sample size obviously makes it impossible to draw definitive conclusions regarding this trend. The fact that all three of the participants scored in the upper percentiles on the Boston Aphasia Exam in their initial evaluations also added to the difficulty in demonstrating a large change. The positive trend we were able to document on both dexterity and speech was consistent with the outcomes of previous studies examining the impact of yoga practice on dexterity, on auditory and visual reaction time, and on cognitive performance in healthy participants.

Despite the limitations imposed by the small sample size, we feel that this study illustrates the potential benefits of Kundalini yoga on speech impairment and demonstrates the need for further studies of the effects of Kundalini not only on stroke-induced aphasia but also on other speech disorders such as stuttering and speech impedi-

ments. The combined positive effects of Kundalini yoga on both the cognitive and physical conditions examined in this study suggest that many other medical problems could be benefited as well.

There are several other limitations in this pilot study that must be mentioned here. It is certainly possible that the positive effects found here could be due to a retest effect, that is, the effect of practice in performing the outcome measure. However, the 12-week interval between assessments would probably make this effect quite small. It is also possible that there could have been a general improvement over time independent of the yoga. However, because all of the stroke patients were more than 6-months poststroke—a point at which improvement in aphasia has typically begun to plateau—the likelihood that this effect explains the entire benefit demonstrated in the study is small.

Kundalini yoga technique has great potential in the treatment of poststroke disability. Future studies should obviously strive for larger sample sizes, and, based on the literature to date, should try to incorporate yoga practice daily rather than only twice weekly. The present study, though small, suggests a methodology for examining the benefits of Kundalini in a larger sample of stroke patients with speech and motor impairments.

Acknowledgments

We would like to thank Prana Mandir yoga center in New York for its support of this study. Specifically, yoga teachers Lea Kraemer, Jessica Beckwith, Diona Dion Arivas, Teresa Kornicoski, and Ann Robideaux should be recognized.

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