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Poststroke Balance Improves With Yoga
A Pilot Study

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Background and Purpose—Balance impairment is common after stroke; modified yoga may be able to improve balance and other important poststroke variables. Scientific-evidence is needed to support such treatment interventions. The purpose of this study was to assess the impact of a yoga-based rehabilitation intervention on balance, balance self-efficacy, fear of falling (FoF), and quality of life after stroke.

Methods—This was a prospective, randomized, pilot study of yoga-based rehabilitation for people with chronic stroke. All yoga sessions were taught by a registered yoga therapist, occurred twice per week for 8 weeks and included seated, standing, and floor postures with relaxation and meditation. Balance was assessed with the Berg Balance Scale, balance self-efficacy with the Activities-specific Balance Confidence Scale, FoF with a dichotomous yes/no question, and quality of life with the Stroke Specific Quality of Life scale.

Results—There were no significant differences between wait-list control (n=10) and yoga (n=37) groups in baseline or follow-up scores. However, using within-group comparisons, yoga group data demonstrated significant improvement in balance (Berg Balance Scale, 41.3 ± 11.7 vs 46.3 ± 9.1; $P<0.001$) and FoF (51% vs 46% with FoF; $P<0.001$).

Conclusions—A group yoga-based rehabilitation intervention for people with chronic stroke has potential in improving multiple poststroke variables. Group yoga may be complementary to rehabilitation, may be possible in medical-based and community-based settings, and may be cost-effective. Further testing of group yoga-based rehabilitation interventions is warranted.

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Key Words: balance ■ exercise ■ functional recovery ■ quality of life ■ rehabilitation ■ stroke recovery ■ yoga

S troke is the most common diagnosis among patients treated by rehabilitation therapists.[1] A significant long-term issue poststroke is persistent motor and sensory deficits that are directly associated with balance impairment. Despite early rehabilitation care, balance impairment often continues into the chronic (>6 months) phases of stroke.[2] For example, Tyson et al[3] found 83% of individuals with stroke had balance deficits, which were related to worse physical impairments and disability. Additionally, balance impairment is associated with poststroke falls, and up to 73% of stroke survivors fall after stroke;[4] this high falls incidence often persists and is associated with depression, fractures, and mortality after stroke.[5] Balance impairment and falls are negatively associated with balance self-efficacy and fear of

falling (FoF), and many of these variables are associated with decreased perceived health status and quality of life (QoL).[6–9]

Clinical Practice Guidelines indicate individuals with post-stroke balance impairment should receive balance training.[2] This, in part, is attributable to neuroplasticity, allowing motor recovery during the chronic stages of stroke recovery.[10] However, no specific balance training recommendations are currently available.[2] This is likely attributable to the lack of large, randomized, controlled trails primarily focused on balance improvement during the chronic phases of stroke recovery. The majority of evidence for poststroke balance training is currently derived from: studies with balance as a secondary outcome; case studies; small studies (10–20 study participants); studies including the distribution of an assistive
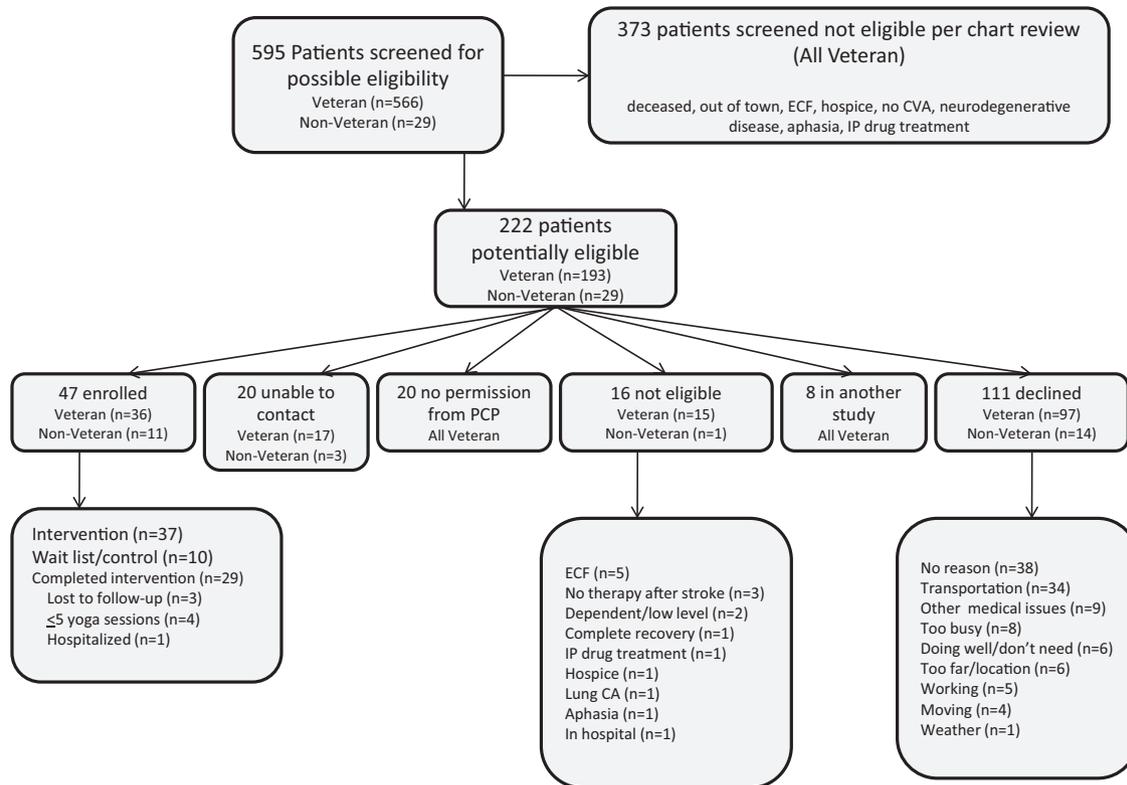
Figure. Consort diagram.

device but no balance training; or studies during the early (1–3 months), but not chronic, poststroke period.[11,12] Despite these limitations, findings from these studies suggest balance improvement in people with chronic stroke is achievable. Thus, people with chronic stroke should have the opportunity to engage in novel exercise programming for further recovery,[10] which creates a need for rigorous development and testing of progressively challenging interventions.[12]

Yoga may be an intervention used to improve poststroke recovery. Although there is limited literature specific to stroke and yoga, there is growing interest in yoga as a means to improve balance and functioning in older adults.[13] For example, in older adults with FoF, a 12-week yoga intervention improved both balance and FoF.[14] It is thought that yoga is more therapeutic than traditional exercise because of the active mind–body component.[15] Evidence suggests that the combination of postures, breathing, and meditation are most beneficial when utilized together[16] and are considered to produce different effects than simple exercise.[17]

Regarding yoga and stroke recovery, 2 case studies have reported improvements in balance and aspects of QoL,[18,19] whereas qualitative findings from another study support perceived improvement after poststroke yoga in strength, range of motion, and walking.[20] These studies indicate that stroke survivors can physically and cognitively engage in and benefit from yoga. Yoga may be especially effective in improving function poststroke, because it promotes coordination of complex movements, balance, strengthening, and breathing. In support of therapeutic yoga for older adults, the United States Department of Health and Human Services recently stated, "Yoga is often recommended as a form of total-solution exercise for older adults, although there is little scientific evidence to support this recommendation."[21]

Based on previous research, yoga being introduced into clinical settings, and the need for scientific evidence, we sought to develop and pilot test an 8-week yoga-based rehabilitation intervention to improve balance and QoL in people with chronic stroke.

Subjects and Methods

Participants

Adults 18 years and older with chronic stroke (>6 months) were recruited for the study. Potential veterans were screened through chart review to ensure a stroke diagnosis. Veterans were then contacted via an approved letter and follow-up telephone calls. Nonveterans were recruited from local stroke support groups and previously completed stroke research studies. Inclusion criteria were collected over the phone; those meeting criteria were invited to participate in the study (Figure).

Inclusion criteria included: completed all stroke-related rehabilitation; able to stand with or without a device; able to speak and understand English; scored ≥4 out of 6 on the short 6-item Mini-Mental State Examination;[22] and agreed to commit to assessments and 16 sessions of group therapy. Potential participants were excluded if they were receiving palliative care, were unable to ensure transportation to the sessions, or had a self-reported medical contraindication (serious cardiac conditions, serious chronic obstructive pulmonary disease or oxygen dependence, severe weight bearing pain, a history of significant psychiatric illness, uncontrollable diabetes with recent weight loss) or current enrollment in another research trial. Human subject approval was obtained from the Indiana University Institutional Review Board and Veterans Administration Medical Center Research and Development board. All subjects gave written informed consent to participate.

Groups and Randomization

After baseline assessments were completed, participants were randomized to 1 of 3 groups: (1) group yoga; (2) yoga-plus (group yoga plus at-home yoga/relaxation audio recording); or (3) control (wait-list usual care). Because this was a pilot study to examine the efficacy of yoga after stroke, 2 yoga groups and 1 control group (2:1 ratio) were formed. This design allowed more individuals to engage in yoga while maintaining a control group. Additionally, the yoga-plus group was included to incorporate standard clinical practice of home exercise prescription. Although optimal dosing (duration, frequency, and intensity) of stroke rehabilitation interventions is currently unknown,[23] we hypothesized additional benefits for those who completed home yoga/relaxation.

There were no significant differences in demographics, stroke characteristics, or variables of interest at baseline or 8 weeks between the group yoga (n=19) and yoga-plus group (n=18); thus, these data were collapsed into a general yoga group for analyses.

Randomization lists were computer-generated and treatment group assignments were revealed after completion of baseline assessments by opening a sealed opaque envelope. All assessments and yoga sessions were completed at the Indiana University Rehabilitation and Integrative Therapy laboratory.

Outcome Assessments

Assessments were completed face-to-face by the research assistant (physical therapist with 20 years of clinical experience) at baseline and 8 weeks after the completion of the yoga intervention. The research assistant also assisted with the yoga sessions and thus was not blinded to primary outcome assessment. Data were collected on self-reported basic demographics and stroke characteristics, including time since stroke, type of stroke (ischemic, hemorrhagic, brain stem, or do not remember), and stroke-related disability (modified Rankin Scale [mRS]). The mRS is a validated measure of the degree of disability and dependence after stroke[24,25] with 6 categories of disability: 0, no symptoms; 1, no significant disability; 2, slight disability; 3, moderate disability; 4, moderately severe disability; 5, severe disability; and 6, dead. As in previous studies, functional independence was defined as 0 to 2 (slight to no disability) and dependence was defined as 3 to 5 (moderate to severe disability).[26,27]

Balance was assessed with the Berg Balance Scale (BBS), a 14-item physical performance measure of static and dynamic balance found to be reliable and valid after stroke.[28] Scoring ranges from 0 to 56, with higher scores indicating better balance. A score of ≤46 identifies an individual at risk for falls after stroke.[29]

The 16-item Activities-specific Balance Confidence Scale was used to measure balance self-efficacy. The Activities-specific Balance Confidence Scale is a self-report of a participant's self-efficacy in maintaining static and dynamic balance control during functional tasks. The validity and reliability of the Activities-specific Balance Confidence Scale have been previously demonstrated in individuals with stroke.[30] Scoring is "no confidence" (0%) to "completely confident" (100%).

A dichotomous variable was used to measure FoF, a modified version of a previously developed yes/no question, "are you worried or concerned about falling?"[31] This has been used in other studies and is correlated to poststroke FoF.[8,32]

The QoL was measured using the validated 49 items of the Stroke-Specific QoL scale.[33] The Stroke-Specific QoL scale includes assessment of 12 domains: self-care; vision; language; mobility; work; upper extremity; thinking; personality; mood; family; social; and energy. Previous work indicates good psychometric properties.[34]

Intervention

Those randomized to group yoga or yoga-plus completed biweekly hour-long sessions over 8 weeks (16 sessions). There were 5 "waves" of yoga groups, and each wave included up to 10 people. Waves 1 to 4 included only veterans, whereas wave 5 included veterans and nonveterans to allow the inclusion of women and the mixing of veterans and nonveterans. The yoga-based rehabilitation intervention was developed and taught by a registered yoga therapist

Table 1. Yoga-Based Protocol

Position	Description	Yoga Pose
Seated		
Weeks 1–8	Slower, deeper, rhythmic breathing, extended exhale	2:1 breathing
	Bilateral eye movements and hold eyes steady	
	Various head and neck positions & movements	
	Scapular range of motion and arm movements	Receptive gesture
	Finger movements with counting	Mudras
	Seated spinal extension, flexion, lateral flexion, and rotation	Cow, cobra, half moon, and fish king poses
	Hip rotation and stretching with ankle, foot, and toes range of motion	Pigeon pose
	Hand to opposite knee	
Standing		
Weeks 2–8	Standing with or without support	Mountain pose
	Knees bent, up and down on toes	Chair pose
	Hip extension while standing	Locust pose
	Prolonged lunges while standing	Warrior pose
	Toe/ball of foot, small knee bends with feet flat on floor	Awkward pose
Floor or mat table		
Weeks 5–8	Posterior leg stretches	Big toe pose
	Supine extensions: bridge lifts	Bridge pose
	Knees into chest: separately, then both at once	Energy-releasing pose
	Supine relaxation: legs outstretched or knees bent and bound together, feet flat, concentration, and relaxation	Corpse pose, mindfulness meditation

with input from the rehabilitation research team. A standardized protocol was developed with modified postures, breathing, and meditation in sitting, standing, and supine positions. Postures were chosen based on our previous experience with stroke and evidence supporting improved balance via a focus on hip and ankle flexibility and strength.[35] All sessions included focused deep relaxation/meditation (Table 1). Over the 8-week period, yoga sessions were increased in intensity and difficulty to allow for early success and progressive improvement. Mat tables, bolsters, blankets, and yoga straps were used as needed to facilitate yoga postures. A standardized safety protocol was in place for high blood pressure or emergency events.

Stroke survivors randomized to the yoga-plus group completed the same 16 sessions of group yoga, but also received a device with a relaxation audio recording. The device was preloaded with the 20-minute relaxation recording developed by the registered yoga therapist. Participants randomized to this group were asked to listen to the recording ≥3 times each week and to track their use of the device.

Those randomized to the control group completed baseline and 8-week assessments without any intervention or contact during the study time. Consistent with chronic stroke usual care, no one in the control group received stroke-related rehabilitation.

Statistical Analysis

Descriptive statistics (means, standard deviations, frequencies, and proportions as appropriate) were used to describe the sample,

Table 2. Baseline and 8-Week Comparison Between Groups

Variable	All, N=47	Wait-List, n=10	Yoga, n=37	P*
Age	63.1±8.8	60.2±8.9	63.9±8.7	0.44
White	28 (60%)	6 (60%)	22 (59%)	1.00
Male	38 (81%)	10 (100%)	20 (54%)	0.172
Months since stroke	51±40.4	36.4±23.6	54.9±43.2	0.20
Type of stroke, self-report ischemic (vs all other or unknown)	31 (66%)	5 (50%)	26 (70%)	0.30
Baseline				
Disability, independent	26 (55%)	5 (50%)	21 (57%)	0.70
Fear of falling, yes	31 (66%)	3 (30%)	18 (49%)	0.40
Balance	41.4±10.8	41.9±6.7	41.3±11.7	0.66
Balance self-efficacy	61.3±23.6	55.5±26.7	62.9±22.8	0.44
QoL	33.5±8.5	32.7±5.2	33.7±9.2	0.67
8-week				
Disability, independent	30 (64%)	5 (50%)	25 (68%)	0.31
Fear of falling, yes	19 (40%)	2 (20%)	17 (46%)	0.17
Balance	45.8±8.6	43.8±6.3	46.3±9.1	0.32
Balance self-efficacy	64.4±24.3	56.2±25.8	66.8±23.4	0.24
QoL	35.21±8.5	33.0±6.2	35.8±9.1	0.266

QoL indicates quality of life.

*As appropriate, P values were calculated using Fisher exact test for categorical variables and nonparametric Mann-Whitney U tests were performed for continuous variables.

including demographics and stroke characteristics of the entire sample and by group allocation. The last score was carried forward for missing data points (4 individuals did not complete 8-week assessments (9%), 1 control, and 3 yoga). Normality of data was assessed with the Shapiro-Wilks test. Independent t tests (or Mann Whitney U) were used to compare balance, balance self-efficacy, and QoL between those randomized to yoga or wait-list groups. Because this was a pilot study, the study was not powered to detect between group differences. Therefore, paired t tests (or Wilcoxon signed-rank test) were included to assess change between baseline and 8-week variables for each group. A Bonferroni adjustment was used to control for multiple comparisons ($P=0.016$). A χ^2 was used for dichotomous FoF (yes or no) and mRS (independent or dependent) variables.

Results

Forty-seven people were enrolled in the study, with 37 randomized to the yoga group and 10 randomized to the control group (Figure). In the yoga group, 29 completed all 8 weeks of the study with postassessments (3 did not complete postassessments, 4 attended ≤5 sessions, and 1 was hospitalized for

reasons unrelated to the intervention). Yoga sessions were missed because of lack of transportation, inclement weather, illness, and work. Participants were physically able to complete all planned yoga activities and no injuries were sustained. There were no baseline differences in demographics, stroke characteristics, or baseline scores between those who did and did not complete the study.

There were no differences between the control (n=10) and yoga groups (n=37) in baseline or 8-week demographics, stroke characteristics, or variables of interest (Table 2). When assessing within-group differences, there were no significant changes in the variables of interest in the control group but changes were found in the yoga group. After the Bonferroni correction, balance (BBS, 41.3±11.7 vs 46.3±9.1; $P<0.001$) improved significantly between baseline and 8 weeks for those in the yoga group (n=37) (Table 3). At 8 weeks, fewer subjects said "yes" to FoF (51% vs 46%; $P<0.001$) and there was a significant increase in the number of people identified

Table 3. Change in Score Between Baseline and 8-Week (N=47)

Variables	Wait-List Control, n=10			Yoga, n=37			Yoga (Completed Yoga), n=29		
	Baseline	8-Week	P*	Baseline	8-Week	P*	Baseline	8-Week	P*
Disability, independent	5 (50%)	5 (50%)	0.21	21 (57%)	25 (68%)	<0.001	15 (52%)	19 (66%)	<0.001
Fear of falling, yes	3 (30%)	2 (20%)	0.07	19 (51%)	17 (46%)	<0.001	17 (60%)	12 (43%)	0.002
Balance	41.9±6.7	43.8±6.3	0.06	41.3±11.7	46.3±9.1	<0.001†	40.7±12.1	47±9.6	<0.001†
Balance self-efficacy	55.5±26.7	56.2±25.8	0.934	62.9±22.8	66.8±23.4	0.18	61.3±21.8	67.2±23.1	0.035
QoL	32.7±5.2	33.0±6.2	0.76	33.7±9.2	35.8±9.1	0.03	33.2±9.3	35.8±9.6	0.037

QoI indicates quality of life.

*As appropriate, P values were calculated using Fisher exact test for categorical variables and nonparametric Wilcoxon signed-rank test for continuous variables.

†Significant after Bonferroni.

as "independent" on the mRS (57% vs 68%; $P<0.001$). Those who completed the yoga intervention (n=29) had significant improvement in balance, mRS, and FoF, with a trend toward significant improvement in QoL ($P=0.037$) and balance self-efficacy ($P=0.035$). In a post hoc analysis, baseline to 8-week change in balance was assessed for only those with baseline balance impairment (BBS ≤46). Balance scores significantly improved for those in the intervention group (n=20; 33.5±10.8 vs 41.5±9.7; $P<0.001$).

Discussion

Despite its relatively small size, we found significantly improved scores for balance and other variables for a group yoga intervention. There was a clinically meaningful improvement in balance among yoga participants (mean BBS increase >6 points), and those who completed yoga crossed the threshold of balance impairment and fall risk by increasing the average score to >46. Interestingly, there was even greater improvement for those with baseline balance impairment (BBS ≤46; mean BBS increase of 8 points).[36] These improvements are larger than what is typically found in the older adult yoga literature and thus indicates an opportunity for even more improvement for older adults with stroke-related balance impairments. Although those with balance impairment sustained a larger increase in balance scores, they did not cross the threshold of >46 (less balance impairment and fall risk), in contrast to the scores for the entire group who were randomized to yoga and who completed yoga. Further research needs to investigate whether continued programming would lead to improvements beyond this threshold.

Interestingly, balance self-efficacy improved, but only for those considered to have completed the yoga intervention (n=29). Perhaps balance self-efficacy was improved with balance and increased practice, and also with the increased social participation and engagement in the environment that is inherent with a group intervention. A possible explanation was offered by study participants in postintervention interviews. Because of improved balance, participants increasingly attempted new activities in different and more challenging environments and were aware of potential fall risk but grew confident in maintaining their balance. None of the studies of yoga after stroke included self-efficacy, and studies in the older-adult literature did not identify an improvement in balance self-efficacy. Although there was not a significant change, there was a trend for improvement consistent with a clinically meaningful change in Activities-specific Balance Confidence Scale outcomes (Table 3). It is likely that with a larger sample size there would be a statistically significant improvement in balance self-efficacy. Improvement in Activities-specific Balance Confidence Scale scores neared significance and increased to >67, indicating a reduction in fall risk.[37] Recently, balance self-efficacy was found to be a primary predictor of activity and participation after stroke; therefore this may be an important variable to focus on for this population.[38] Bandura identifies self-efficacy as one's belief in his or her ability to execute a plan to complete a task or attain a result.[39,40] Perhaps individuals who completed the yoga intervention were able to improve their confidence in balance-related tasks, but this likely took time, an increase in balance, and opportunities to successfully challenge their balance without sustaining a fall (as practiced in the yoga sessions).

Limitations of this study include the unblinded outcome assessment, the relatively small sample size, the low enrollment of women, the mRS is a weak measure of disability with floor effects, and the dichotomous FoF question rather than a standardized assessment. Additionally, it would be interesting to assess who the intervention is most likely to benefit; however, the small sample size does not allow for this because there would be too few people in each group to examine differences in type of stroke, side of stroke, or other important variables.

Despite these limitations, this pilot study demonstrates that a modified yoga intervention for people with chronic stroke is feasible and potentially of great benefit. The improvement in balance is statistically significant and clinically meaningful and is larger than previously reported in other poststroke exercise trials. Group yoga should be further studied as a possible feasible and effective intervention to improve balance, QoL, and participation poststroke.

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Disclosures

None.

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