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Original Article

Effects of Otago Exercises and Gaze Stabilization Exercises on Balance, Gait and Quality of Life in Elderly Stroke Patients

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ABSTRACT

Background: Balance impairment, gait dysfunction, and reduced quality of life are common consequences of stroke. Gaze stabilization and Otago exercises target different components of postural and mobility control, but their comparative effects after stroke remain uncertain. **Objective:** To compare the effects of gaze stabilization exercises, Otago exercises, and conventional treatment on balance, dynamic gait, and stroke-specific quality of life in adults with stroke. **Methods:** This assessor-blinded, three-group randomized clinical trial included 66 participants aged 50–70 years, with 22 participants assigned to each group. Group A received gaze stabilization exercises with conventional treatment, Group B received Otago exercises with conventional treatment, and Group C received conventional treatment alone. Interventions were delivered for 40 minutes per session, five days weekly for eight weeks. Outcomes were assessed at baseline, four weeks, and eight weeks using the Berg Balance Scale, Dynamic Gait Index, and Stroke-Specific Quality of Life scale. **Results:** All groups demonstrated significant within-group improvements in all three outcomes over time (all $p<0.001$). At eight weeks, between-group differences were significant for balance ($F=103.255$, $p<0.001$), dynamic gait ($F=28.685$, $p<0.001$), and quality of life ($F=6.957$, $p=0.002$). Group A showed the largest mean improvements in BBS (+11.409), DGI (+7.728), and SSQoL (+31.318). Group A was superior to both other groups for BBS and DGI, whereas its SSQoL score differed significantly from Group C but not Group B. **Conclusion:** Gaze stabilization exercises produced the largest improvements in balance and dynamic gait. Both gaze stabilization and Otago exercises improved stroke-specific quality of life, although their eight-week SSQoL scores did not differ significantly. **Keywords:** Balance; Gait; Gaze Stabilization; Otago Exercise Programme; Quality of Life; Stroke Rehabilitation.

INTRODUCTION

Stroke remains a major global cause of mortality, long-term neurological impairment, and disability. It occurs when the cerebral blood supply is interrupted by vascular occlusion or intracranial haemorrhage, resulting in acute neurological dysfunction and variable deficits in movement, sensation, cognition, communication, and functional independence. Although survival after stroke has improved, many survivors experience persistent limitations that restrict activities of daily living, community participation, and health-related quality of life. The burden is particularly important in populations with

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a high prevalence of modifiable vascular risk factors, including hypertension, diabetes mellitus, smoking, obesity, and physical inactivity (1).

Impaired balance and walking ability are among the most disabling consequences of stroke. These problems may arise from muscle weakness, altered tone, reduced trunk control, impaired proprioception, vestibular dysfunction, restricted visual–vestibular integration, and inadequate coordination of sensory information required for postural control. Stroke survivors may consequently demonstrate reduced walking speed, impaired adaptability during dynamic tasks, increased fear of falling, dependence on mobility aids, and greater reliance on caregivers. Persistent balance and gait limitations also restrict social participation and may adversely affect psychological wellbeing and stroke-specific quality of life. Previous rehabilitation studies have therefore emphasized interventions that address postural stability, visual orientation, dynamic balance, and safe mobility after stroke (2–6).

Exercise-based rehabilitation is central to the recovery of mobility and functional independence following stroke. The Otago Exercise Programme was originally developed as a structured fall-prevention intervention for older adults and incorporates progressive lower-limb strengthening, balance retraining, and walking practice. Its components are intended to improve muscular control, postural stability, confidence during mobility, and the ability to respond safely to environmental challenges. Evidence from older populations supports the role of the Otago programme in reducing fall risk and improving physical function, while stroke-specific evidence suggests that its strength and balance components may also be applicable to individuals experiencing post-stroke mobility limitations (6–8).

Gaze stabilization exercises represent a different but potentially relevant rehabilitation approach. These exercises are designed to improve the ability to maintain visual fixation during head movement by training visual–vestibular coordination and the vestibulo-ocular reflex. Following stroke, impaired integration of visual, vestibular, and somatosensory information may compromise spatial orientation and stability during standing and walking. Gaze stabilization training may therefore support postural control by improving visual clarity during movement, head and trunk coordination, dynamic balance, and adaptability during gait. Clinical trials involving individuals with subacute and chronic stroke have reported improvements in balance, gait performance, plantar-pressure distribution, and fall-related outcomes after gaze stabilization or related oculomotor rehabilitation programmes (2–5).

Although the Otago Exercise Programme and gaze stabilization exercises have each demonstrated potential rehabilitation benefits, the available evidence has frequently examined these interventions separately or compared them with conventional treatment. A previous randomized trial directly compared Otago exercises with gaze-stability training in older adults, but direct evidence comparing both interventions with conventional therapy among people recovering from stroke remains limited (9). A three-group comparison may help determine whether an intervention directed primarily toward visual–vestibular control produces different outcomes from a structured strength-and-balance programme when both are delivered alongside conventional rehabilitation. Therefore, this randomized clinical trial compared the effects of gaze stabilization exercises combined with conventional treatment, Otago exercises combined with conventional treatment, and conventional treatment alone on balance, dynamic gait, and stroke-specific quality of life over eight weeks in adults aged 50–70 years who had experienced an ischaemic or haemorrhagic stroke within the preceding six months.

MATERIALS AND METHODS

This three-arm, parallel-group, assessor-blinded randomized clinical trial was conducted at Riphah Rehabilitation Center and General Hospital, Lahore, over a seven-month period following approval of the study synopsis. Adults with stroke receiving rehabilitation services at the participating centres were recruited through non-probability convenience sampling. Convenience sampling was used for participant recruitment, after which eligible participants were randomly allocated to one of the three treatment groups.

The sample size was estimated using G*Power version 3.1.9.7 and was informed by a previous study comparing the Otago Exercise Programme with gaze-stability exercises (9). The calculation used a significance level of 0.05, statistical power of 80%, and an effect size of 0.55. After allowing for an anticipated attrition rate of 20%, the final target sample was 66 participants, with 22 participants allocated to each treatment group.

Men and women aged 50–70 years were eligible when they had experienced an ischaemic or haemorrhagic stroke within the previous six months. Participants were required to have a Berg Balance Scale score of 35–45, a Dynamic Gait Index score of 11–19, and a Mini-Mental State Examination score greater than 24. These thresholds were used to identify individuals with measurable balance and gait limitations who retained sufficient cognitive ability to understand and participate in the intervention and assessment procedures. Individuals were excluded when they had a severe visual or hearing impairment, another neurological or musculoskeletal condition that could substantially affect balance or mobility, a peripheral vestibular disorder, recent surgery, a severe cardiac condition, or current use of medication specifically affecting balance.

Eligible participants were allocated in a 1:1:1 ratio using a computer-based randomization procedure. Group A received gaze stabilization exercises in addition to conventional treatment, Group B received Otago exercises in addition to conventional treatment, and Group C received conventional treatment alone. The outcome assessors remained unaware of treatment allocation, making the study assessor-blinded. Participants and treating therapists could not be blinded because the exercise content differed visibly among the groups.

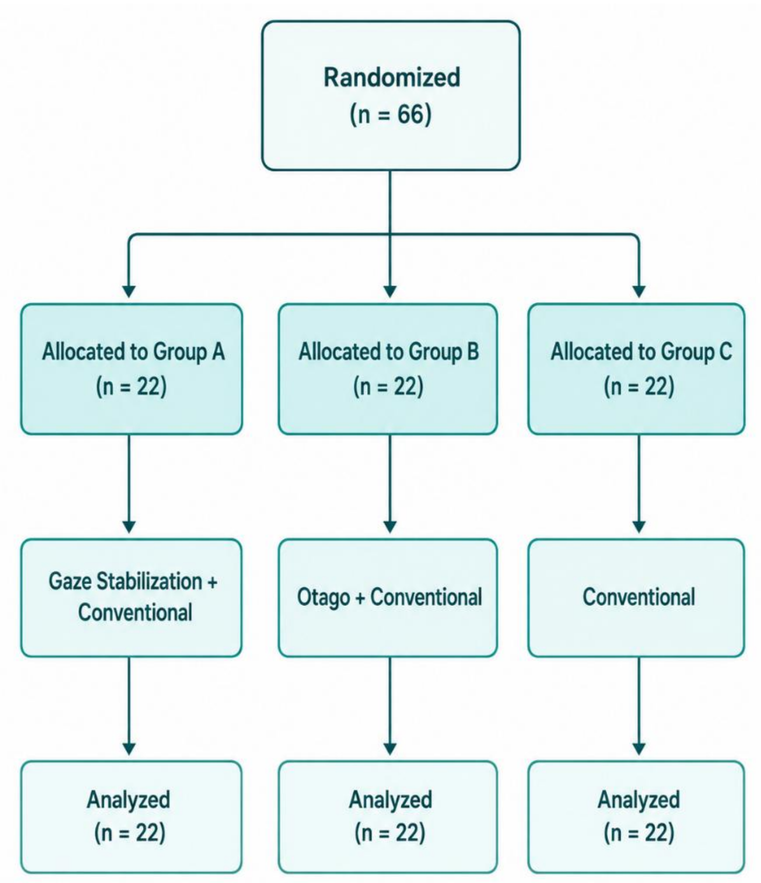

Figure 1 CONSORT Flowchart

The assigned interventions were delivered for eight weeks, with five treatment sessions per week. Each session lasted approximately 40 minutes, including warm-up and cool-down periods. Participants in Group A performed gaze stabilization exercises together with conventional treatment. Participants in Group B performed the Otago Exercise Programme together with conventional treatment. Participants in Group C received the conventional treatment used at the participating rehabilitation centres. The treatment schedule was maintained consistently across the eight-week intervention period.

Balance was assessed using the Berg Balance Scale, dynamic walking ability was evaluated using the Dynamic Gait Index, and stroke-related quality of life was assessed using the Stroke-Specific Quality of Life scale. These instruments represented complementary domains of post-stroke recovery and have been used in previous clinical investigations of gaze stabilization and related rehabilitation interventions (2–5). The Mini-Mental State Examination was used during eligibility assessment to determine whether participants met the required cognitive threshold. The principal outcomes were assessed at baseline, after four weeks of intervention, and after completion of the eight-week treatment period. Assessments were conducted by outcome assessors who were blinded to the assigned intervention group.

Data were analysed using IBM SPSS Statistics version 26.0. Continuous variables were summarized as mean and standard deviation, while categorical variables were presented as frequencies and percentages. Distributional assumptions for the Berg Balance Scale, Dynamic Gait Index, and Stroke-Specific Quality of Life scores were evaluated using the Kolmogorov–Smirnov and Shapiro–Wilk tests. Between-group differences in continuous outcome scores at baseline, four weeks, and eight weeks were examined using one-way analysis of variance. When an omnibus between-group test was statistically significant, post hoc pairwise comparisons were performed to identify the groups contributing to the observed difference. Changes across baseline, four-week, and eight-week assessments were evaluated within each treatment group using repeated-measures analysis of variance. Statistical tests were two-sided, the confidence level was set at 95%, and a p-value below 0.05 was considered statistically significant.

RESULTS

Data were reported for 66 participants, with 22 participants in each intervention group. The participants had mean ages ranging from 55.636 to 57.181 years, mean body mass index values ranging from 26.222 to 26.715 kg/m², and mean Mini-Mental State Examination scores ranging from 25.909 to 26.000. No statistically significant differences were identified among the three groups in the reported continuous or categorical baseline characteristics.

Table 1. Baseline Characteristics of Participants

Characteristic	Group A: Gaze Stabilization (n=22)	Group B: Otago Exercises (n=22)	Group C: Conventional Treatment (n=22)	p-value
Age, years	57.181 ± 3.899	55.636 ± 2.172	56.454 ± 3.097	0.270
Height, m	1.654 ± 0.060	1.660 ± 0.056	1.655 ± 0.059	0.935
Weight, kg	73.181 ± 10.261	73.636 ± 8.899	71.954 ± 9.653	0.836
BMI, kg/m²	26.695 ± 3.091	26.715 ± 3.241	26.222 ± 2.907	0.835
MMSE score	25.909 ± 1.191	26.000 ± 1.272	25.954 ± 1.252	0.971
Male	10 (45.5)	13 (59.1)	14 (63.6)	0.449
Female	12 (54.5)	9 (40.9)	8 (36.4)	—
Married	18 (81.8)	20 (90.9)	19 (86.4)	0.680
Unmarried	4 (18.2)	2 (9.1)	3 (13.6)	—
Rural residence	9 (40.9)	7 (31.8)	8 (36.4)	0.822
Urban residence	13 (59.1)	15 (68.2)	14 (63.6)	—
Right-handed	13 (59.1)	15 (68.2)	19 (86.4)	0.126
Left-handed	9 (40.9)	7 (31.8)	3 (13.6)	—
Current smoker	8 (36.4)	9 (40.9)	7 (31.8)	0.976
Ex-smoker	4 (18.2)	4 (18.2)	5 (22.7)	—
Non-smoker	10 (45.5)	9 (40.9)	10 (45.5)	—

Data are presented as mean ± standard deviation or n (%). Continuous variables were compared using one-way analysis of variance, and categorical variables were compared using Pearson's chi-square test. BMI, body mass index; MMSE, Mini-Mental State Examination.

The Berg Balance Scale scores increased significantly within each group. Group A improved from 38.272 ± 2.119 at baseline to 49.681 ± 1.358 at eight weeks, corresponding to an 11.409-point mean increase. The corresponding increases were 7.318 points in Group B and 4.045 points in Group C. Between-group differences were not significant at baseline but became significant at four weeks and eight weeks. At four weeks, Group A had significantly higher BBS scores than Groups B and C, whereas Groups B and C did not differ significantly. At eight weeks, all three pairwise comparisons were statistically significant, with the highest score in Group A, followed by Group B and Group C.

Dynamic Gait Index scores also improved significantly within all groups. The eight-week mean increase was 7.728 points in Group A, 5.318 points in Group B, and 3.500 points in Group C. The groups were comparable at baseline, but significant between-group differences were observed at four and eight weeks. Group A had higher DGI scores than Groups B and C at both follow-up assessments, and Group B also had higher scores than Group C.

Stroke-Specific Quality of Life scores increased significantly within all three groups. Group A improved by 31.318 points, Group B by 28.363 points, and Group C by 26.046 points between baseline and eight weeks. The overall between-group comparison was significant at four weeks and eight weeks. However, the pairwise findings were more limited than those observed for balance and gait. At both follow-up assessments, Group A differed significantly from Group C, whereas the differences between Groups A and B and between Groups B and C were not statistically significant.

Table 2. Longitudinal Changes in Balance, Dynamic Gait, and Stroke-Specific Quality of Life

Outcome	Group	Baseline, mean ± SD	Week 4, mean ± SD	Week 8, mean ± SD	Baseline-to week-8 change	Within-group F	p-value
BBS	Group A	38.272 ± 2.119	44.636 ± 2.082	49.681 ± 1.358	11.409	507.981	<0.001
	Group B	38.136 ± 2.007	41.818 ± 1.735	45.454 ± 1.223	7.318	263.211	<0.001
	Group C	39.409 ± 2.737	41.500 ± 2.064	43.454 ± 1.765	4.045	82.699	<0.001
DGI	Group A	14.181 ± 2.038	18.681 ± 2.190	21.909 ± 2.091	7.728	389.169	<0.001
	Group B	14.500 ± 1.896	16.818 ± 1.893	19.818 ± 1.893	5.318	696.051	<0.001
	Group C	14.181 ± 1.789	15.363 ± 1.528	17.681 ± 1.523	3.500	141.764	<0.001
SSQoL	Group A	57.227 ± 8.596	81.000 ± 5.968	88.545 ± 5.704	31.318	458.279	<0.001
	Group B	55.909 ± 7.903	75.545 ± 7.626	84.272 ± 7.125	28.363	1276.600	<0.001
	Group C	53.454 ± 8.313	71.363 ± 12.350	79.500 ± 10.532	26.046	997.202	<0.001

BBS, Berg Balance Scale; DGI, Dynamic Gait Index; SD, standard deviation; SSQoL, Stroke-Specific Quality of Life. Change scores were calculated by subtracting the reported baseline mean from the reported eight-week mean.

Table 3. Between-Group Comparisons at Baseline and Follow-Up

Outcome	Assessment	F-value	p-value	η^2
BBS	Baseline	2.013	0.142	0.060
	Week 4	16.937	<0.001	0.350
	Week 8	103.255	<0.001	0.766
DGI	Baseline	0.203	0.817	0.006
	Week 4	17.031	<0.001	0.351
	Week 8	28.685	<0.001	0.477
SSQoL	Baseline	1.177	0.315	0.036
	Week 4	6.257	0.003	0.166
	Week 8	6.957	0.002	0.181

η^2 was calculated from the reported one-way ANOVA statistics using between-group and residual degrees of freedom of 2 and 63, respectively. BBS, Berg Balance Scale; DGI, Dynamic Gait Index; SSQoL, Stroke-Specific Quality of Life.

The magnitude of the between-group effect was largest for BBS at eight weeks (η^2=0.766), followed by DGI at eight weeks (η^2=0.477). The between-group effects for SSQoL were smaller at four weeks (η^2=0.166) and eight weeks (η^2=0.181). The standardized eight-week differences between Groups A and B were large for BBS (d=3.271), large for DGI (d=1.048), and moderate for SSQoL (d=0.662). Nevertheless, the reported post hoc test did not identify a statistically significant eight-week SSQoL difference between Groups A and B.

Table 4. Post Hoc Pairwise Comparisons at Four and Eight Weeks

Outcome	Assessment	Comparison	Mean difference	95% CI	p-value	Cohen's d
BBS	Week 4	Group A – Group B	2.818	1.633 to 4.003	<0.001	1.470
	Week 4	Group B – Group C	0.318	−0.867 to 1.503	0.854	0.167
	Week 4	Group A – Group C	3.136	1.951 to 4.321	<0.001	1.513
	Week 8	Group A – Group B	4.227	3.344 to 5.110	<0.001	3.271
	Week 8	Group B – Group C	2.000	1.117 to 2.883	<0.001	1.317
	Week 8	Group A – Group C	6.227	5.344 to 7.110	<0.001	3.954
DGI	Week 4	Group A – Group B	1.863	0.726 to 3.000	0.005	0.910
	Week 4	Group B – Group C	1.454	0.317 to 2.591	0.035	0.846
	Week 4	Group A – Group C	3.318	2.181 to 4.455	<0.001	1.757
	Week 8	Group A – Group B	2.090	0.975 to 3.205	0.001	1.048
	Week 8	Group B – Group C	2.136	1.021 to 3.251	0.001	1.244
	Week 8	Group A – Group C	4.227	3.112 to 5.342	<0.001	2.311
SSQoL	Week 4	Group A – Group B	5.454	−0.005 to 10.913	0.121	0.797
	Week 4	Group B – Group C	4.181	−1.278 to 9.640	0.284	0.407
	Week 4	Group A – Group C	9.636	4.177 to 15.095	0.002	0.994
	Week 8	Group A – Group B	4.272	−0.576 to 9.120	0.191	0.662
	Week 8	Group B – Group C	4.772	−0.076 to 9.620	0.129	0.531
	Week 8	Group A – Group C	9.045	4.197 to 13.893	0.001	1.068

Positive mean differences favour the first-listed group because higher scores indicate better outcomes. Confidence intervals were calculated from the reported standard errors using the residual degrees of freedom from the one-way ANOVA and are unadjusted intervals. The p-values are the post hoc values reported in the source tables. Cohen's d was calculated using the reported group means, standard deviations, and equal group sizes. BBS, Berg Balance Scale; CI, confidence interval; DGI, Dynamic Gait Index; SSQoL, Stroke-Specific Quality of Life.

DISCUSSION

This randomized clinical trial compared gaze stabilization exercises combined with conventional treatment, Otago exercises combined with conventional treatment, and conventional treatment alone in adults recovering from stroke. All three groups demonstrated statistically significant improvements in balance, dynamic gait, and stroke-specific quality of life over eight weeks. However, the magnitude and pattern of improvement differed across outcomes. Gaze stabilization exercises produced the largest observed gains in balance and dynamic gait and were significantly better than both Otago exercises and conventional treatment at eight weeks. For stroke-specific quality of life, gaze stabilization produced the highest mean score, but the difference between gaze stabilization and Otago exercises was not statistically significant.

Balance improved in each group, but the greatest change occurred in the gaze stabilization group. The 11.409-point increase in BBS in Group A exceeded the corresponding increases of 7.318 points in the Otago group and 4.045 points in the conventional-treatment group. At four weeks, Group A already demonstrated significantly higher balance scores than both other groups, and by eight weeks all pairwise comparisons were significant. These findings are consistent with previous evidence that oculomotor and gaze-stability training can improve balance and reduce fall-related impairment after stroke (2). Randomized studies have also reported improvements in balance after gaze stabilization exercises among people with chronic and subacute stroke, supporting the relevance of visual–vestibular rehabilitation across different stages of recovery (4,5).

The greater balance improvement associated with gaze stabilization may reflect enhanced integration of visual, vestibular, and somatosensory information during postural tasks. Maintaining visual fixation while the head moves requires adaptive control of the vestibulo-ocular reflex and coordinated stabilization of the head, trunk, and lower extremities. Repeated exposure to these tasks may improve the ability to maintain orientation during standing and movement. Zhao et al. similarly reported beneficial effects of gaze stabilization on balance, gait, and plantar-pressure characteristics after stroke, suggesting that visual–vestibular training may influence both postural control and lower-limb loading patterns (3).

Dynamic gait improved significantly in all groups, with the greatest increase observed in Group A. At eight weeks, the gaze stabilization group had a mean DGI score of 21.909 ± 2.091 compared with 19.818 ± 1.893 in the Otago group and 17.681 ± 1.523 in the conventional-treatment group. All pairwise differences were statistically significant. Dynamic walking requires simultaneous control of visual orientation, head movement, balance reactions, obstacle negotiation, and changes in walking speed or direction. Gaze stabilization may have provided additional task-specific training for these demands by challenging visual fixation during head and body movement. This interpretation is consistent with previous stroke studies reporting improved gait performance after gaze stabilization and oculomotor rehabilitation (2–5).

The Otago group also demonstrated clinically relevant improvements in balance and gait and performed significantly better than conventional treatment for both outcomes at eight weeks. The Otago Exercise Programme combines progressive lower-limb strengthening, balance activities, and walking practice, which may enhance postural responses, weight transfer, lower-extremity control, and confidence during mobility. A systematic review and meta-analysis has supported the effectiveness of the Otago programme for fall prevention, while studies in older adults have reported improvements in physical function and fear of falling (7,10). Stroke-specific evidence remains less extensive, although case-based findings and direct comparisons in older populations suggest that the programme may be adaptable for individuals with neurological balance impairment (8,9).

Stroke-specific quality of life improved substantially in all groups. Although Group A had the highest eight-week mean, its difference from Group B was not statistically significant. Similarly, Group B did not differ significantly from Group C. Only the comparison between Groups A and C reached statistical significance at both follow-up assessments. These findings indicate that the evidence for differential treatment effects was stronger for performance-based balance and gait outcomes than for the broader quality-of-life measure. Quality of life is multidimensional and may be influenced by physical independence, emotional status, communication, family support, social participation, comorbidities, and expectations. Improvements in physical performance may therefore not produce proportionally equivalent differences in overall quality-of-life scores during a relatively short intervention period. Evidence from individuals with chronic dizziness also suggests that adding gaze stabilization to balance training can improve clinical outcomes, although differences in diagnosis and population limit direct comparison with stroke rehabilitation (11).

The significant improvements observed in the conventional-treatment group should not be interpreted as an absence of treatment response. Conventional rehabilitation may improve mobility through repeated practice, strengthening, balance activities, and functional training. Furthermore, because participants had experienced stroke within the preceding six months, part of the improvement across all groups may have been associated with ongoing neurological and functional recovery. The additional improvements in Groups A and B suggest that structured targeted exercises may augment conventional rehabilitation, but the available analyses do not establish the independent contribution of each treatment component.

The study had several strengths, including its randomized three-group design, assessor blinding, equal group sizes, inclusion of both performance-based and patient-reported outcomes, and repeated assessment at clinically relevant intervals. Nevertheless, the findings should be interpreted in relation to several limitations. Participants were recruited through convenience sampling from two rehabilitation centres in Lahore, which may limit external validity. The sample was relatively small, and the eight-week follow-up did not establish whether the improvements were sustained. Potentially influential factors such as medication use, comorbidities, stroke severity, lesion characteristics, time since stroke, baseline functional status, adherence, and additional rehabilitation exposure were not incorporated into the reported analysis. Stroke-specific quality of life was self-reported and may have been affected by response bias. The analysis used separate between-group comparisons at each assessment and repeated-measures tests within each group rather than a single group-by-time interaction model. Consequently, the comparative treatment trajectories could not be quantified directly. Future trials should use concealed allocation, prospectively registered protocols, detailed intervention-fidelity assessment, adverse-event reporting, longer follow-up, and mixed-effects or group-by-time analyses.

CONCLUSION

Gaze stabilization exercises combined with conventional treatment produced the largest observed improvements in balance and dynamic gait over eight weeks and resulted in significantly better BBS and DGI scores than Otago exercises or conventional treatment alone. Otago exercises also improved balance and gait and were more effective than conventional treatment at eight weeks. Stroke-specific quality of life improved in all groups; however, gaze stabilization differed significantly from conventional treatment but not from Otago exercises. These findings support the inclusion of targeted gaze stabilization or structured Otago exercises within post-stroke rehabilitation, with the strongest comparative evidence favouring gaze stabilization for balance and dynamic gait outcomes.

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