ISC
License Number: 00201-57079
1st International Conference on Educational Sciences, Psychology, Sport Sciences and Physical Education
www.confep.ir
Adib Mazandaran Institute of Higher Education

Effectiveness of Dynamic Neuromuscular Stabilization Exercises on Balance and Gait Parameters in Patients With Alzheimer Disease

Faezeh Shah Mohammadi

Abstract

Purpose: This study aimed to investigate the effectiveness of dynamic neuromuscular stabilization (DNS) exercises on balance and gait parameters in patients with Alzheimer's disease (AD).
Materials and methods: Thirty elderly individuals with AD were allocated into DNS (N=15) and control (N=15) groups. Balance was assessed with time up to go (TUG) test. Gait velocity (GV), step length (SL), and step width (SW) were assessed with walking on a 10 m distance and 2-D camera capturing. Paired t-test and analysis of covariance (ANCOVA) were respectively used for analysis of within and between-group differences.
Results: There was significant within-group difference for balance (P= 0.001), GV (P= 0.001), SL (P= 0.003), and SW (P= 0.01). No significant difference was observed in the control group (P> 0.05). DNS exercises showed significant differences compared to no intervention (P< 0.05).
Conclusions: It seemed that DNS exercises were more effective than no intervention to improve balance and gait parameters in patients with AD.
Keywords: Alzheimer disease**;** Balance; DNS exercises; Elderly people; Gait parameters

Implications for Rehabilitation

- The gait and balance deficits have been observed in patients with Alzheimer's disease
- Dynamic neuromuscular stabilization is effective to improve balance and gait in patients with Alzheimer's disease

INTRODUCTION

Alzheimer's disease (AD) is one of the common and progressive neurodegenerative disorders that negatively affect memory and thinking skills[1]. In 2014, as many as 5 million Americans were living with Alzheimer's disease and it is predicted that up to 2060 it might project to 14 million people in the United State[1]. A descriptive, analytical study in 2017 indicated the prevalence of AD as 2.3% in the Iranian elderly population[2]. As well as memory and thinking impairments, gait, and balance deficits are frequent in AD patients with a prevalence of near 60% [3]. The gait and balance deficits have been considered as important risk factorsfor falls[4], emergency hospital visits[5], the delay-living functional decline[4], and increased health cost care[6].To solve the gait and balance problem in AD patients, different interventions have been examined. Different pilot studies assessed the effectiveness of a small-group balance exercise or treadmill training program for balance improvement in individuals with AD[7].Both suggested that a small-group functional balance intervention and treadmill training improvement on both cognition and functional capacity [7,8]. In terms of gait impairments, Schwenk et al., (2014) mentioned that a progressive resistance and functional training for 3 months can improve clinically meaningful gait variables in people with dementia [9]. However, with all these, an effective strategy to improve gait and balance with a larger effect size (ES) is required. In terms of effective treatment methods and one of the most important rehabilitation techniques, the Dynamic Neuromuscular Stabilization (DNS) technique is available and includes motor behavior in infants from their birthdate to the time when they begin to walk[10]. In DNS approaches, lack of motor development during infancy leads to neuromuscular disorders, which, in their turn, will emerge as biomechanical deficits in later ages[10]. DNS exercise may be based on the neural growth chain of a healthy infant's locomotor system, which can lead to the re-development of the nervous system in neuromuscular disorder patients[10].DNS exercise mainly focuses on educating core stabilization, training of limb pattern different limb movement, attention to the stability of each part of the chain Muscle involvement in more distant areas, and keeping the spine in its ideal position[10]. The effect of DNS exercise has been previously studied in hemiparetic stroke patients and showed improvement in deep core muscle activation, core stabilization, and muscle thickness[11]. On the other hand, Son et al., (2017) investigated the effect of DNE on gross motor function cerebral palsy individuals. The researchers showed improvement in standing, walking, and jumping in participants with spastic diplegic cerebral palsy. However, this novel intervention has not yet been examined in AD patients[12].Thus, this study aimed to investigate the effect of DNS exercises on balance and gait parameters in patients, compared to no intervention. The significant effect of DNS exercises on gait and balance in AD patients is hypothesized.

MATERIAL AND METHODS

Study design and participants

This study was a quasi-experimental study with a pretest-posttest design that includes an experimental group (DNS exercises) and a control group. The study was approved by the ethical committee of the Islamic Azad University of Karaj, Karaj, Iran. The participants consist of elderly males and females with AD levels 1to 3 and a member of the Iranian Alzheimer's Association. The statistical sample was calculated using the Cochran's formula of 30 people and selected according to the inclusion and exclusion criteria. Inclusion criteria wereAD Patients who have treatment indication according to the criteria of the Ministry of Health and Medical Education of Iran, age between 60 to 75 years. Exclusion criteria werediscontinuing study for any reason for medical treatment, being under 60 years old and above 75 years old and being unable to perform physical activities under certain conditions. Out of 65 patients, 30 patients were eligible to participate in the study, based on the study criteria, and divided into DNS (n= 15) and control (n= 15) group. Then the necessary explanations were given about the steps of conducting the research and the informed consent form was signed by all patients.

Assessment Procedure

Before dividing patients into two groups, an experienced examiner assessed demographic data (age, height, and weight) and the balance and gaitmeasurements.The same examiner repeatedly performed the outcome measurements following the 8-week interventions. At baseline and post-intervention, all outcomes were collected at the laboratory of biomechanics at the university. The interventions were provided at the university health center by a licensed and Persian native speaker physical therapist.

Measurements

The balance was assessed using Time Up to Go (TUG) test. This test is to determine fall risk and measure the progress of balance, sit to stand, and walking[13]. The patients were asked to start in a seated position. Then they need to stand up upon the therapist's command, walks 3 meters, turns around, walk back to the chair, and sit down. The time stops when the patient is seated[13]. In people with AD reliability of TUG is high (ICC = .985-.988) [14].The gait parameters include gait velocity (GV), step length (SL), and step width (SW), and. Gait velocity was measured over a 10 m distance on a flat floor with a total pathway length of 12 m. the GV was assessed based on the method used in the study of Morio etal., (2019) [15]. The patients were asked to walk the 12 m distance as fast as possible without falling. The time taken to walk the 10 m distance in the middle of the 12 m-long walking paths was measured using a stopwatch. The measurement was conducted three times, and the shorter time was used as the record for analysis [15].The stride length and stride width were evaluated using three cameras located in 3 places back, front, and perpendicular to the patients at 2.5 m. SL was defined as the anterior-posterior distance between the heel markers atthe heel strike[16]. SW was defined as the lateral distance between heel markers at heelstrike[16]. Patients wore reflective markers on their trunk and feet (middle third of the thigh, external femoral condyle, the middle third of the tibia, external malleolus, calcaneus, and head of second metatarsal [17]) and asked to walk with self-selected and comfortable seed along with the 11 long-distance[18]. Three Vicon (Oxford Metrics, Oxford, UK) cameras captured patients' motion at 60 Hz. Vicon Nexus software was used to reconstruct, label, and export the data for further processing in Kinovea®software version 0.8.15. The reliability of Kinovea® software and gait analysis has previously reported (ICC > 0.85) [18].

DNS exercises

The patients in the experimental group were instructed to performed DNS exercise for 8 weeks, 3 sessions in a week, and 40 to 60 minutes for each session. The DNS exercises were based on the study of Frank et al., (2013) [19]. The patients first did general warm-ups for 10 minutes and then performed selected exercises under the supervision of a physical therapist. The therapist monitored the quality and duration of exercises and kept track of training sessions for each participant. The therapist ensured that the exercises were performed properly. Exercises include 24 DNS exercises, 8 simple level exercises in the first and second weeks (table 1, supplemental appendix 1), 8 intermediate level in the third, fourth, and fifth weeks (table 2, supplemental appendix 1), and 8 advanced levels in the sixth, seventh and eighth weeks (table 3, supplemental appendix 1).The goal of the DNS approach was to restore the integrated spinal stabilizing system via specific exercises based on the developmental kinesiological positions.

Control group

Patients in control group received usual treatment with access to memory clinic staff if medical or other needs necessitated contact during the study period. In order to increase adherence and positive expectations to the study, all control group subjects were offered DNS exercises after the termination of the study.

Statistical analysis

Shapiro–Wilk test was used to check the normality of the data. Then, descriptive statistics of mean and standard deviation were used to describe the information. A paired t-test was used to compare the within-group results and analysis of covariance (ANCOVA) as a general linear model used to compare the between-group results. 95% confidence intervals (CI95%) were calculated based on the adjusted group mean differences and effect sizes of the mean group differences were calculated as Cohen's D (0.2= small effect, 0.5= moderate effect, and 0.8= large effect) [20]. A significant level was considered at the level of 95% with an alpha lower than 0.05.All statistical analyzes were performed using SPSS software version 19.

RESULTS

The data were analyzed for 30 (Male: 17, Female: 13) patients with AD who finished the exercises for 8 weeks. There were no significant differences among the groups in demographic data(Table1).

Table 1. Demographic data scores at baseline

Demographic data	**Group**	***P*-value**

	DNS Mean±SD	Control Mean±SD	
Age (year)	71.45±5.23	70.40±3.83	0.17
Height (cm)	162.51±6.32	161.62±3.46	0.83
Weight (kg)	70.53±4.35	71.41±4.26	0.57

SD= Standard Deviation, DNS= Dynamic Neuromuscular Stabilization

The results of paired t-test showed that there was significant within-group difference between pre-test and post-test in the DNS group for balance (P= 0.001; ES= -1.89), GV (P= 0.001; ES= 0.78), SL (P= 0.003; ES= 0.10), and SW (P= 0.01; ES= -0.75). No significant difference in the control group (P> 0.05).

The result of the between-group ANCOVA analysis showed significant and superior effects of DNS group over control group for all measured outcomes (for balance (F= 9.56; P= 0.002), for GV (F= 9.06; P= 0.01), for SL (F= 18.56; P= 0.001), and for SW (F= 19.56; P= 0.006)) (Table 2).

Table 2. Mixed within-between groups for the balance and gait parameters outcomes assessed in the study

Outcome	Groups	Pre-test Mean±SD	Post-test Mean±SD	Effect size and 95% CI (Lower limit -Upper limit)	*P*	Between-groupANCOVA analysis
Balance (TUG) (sec.)	DNS	27.69±2.74	22.63±2.59	-1.89 (-3.11 - -0.67)	0.001Ω	F=9.56 P= 0.002*
	Control	28.36±1.44	27.2±8.22	-0.19 (-1.21 - 0.81)	0.69	
Gait velocity (m/s)	DNS	1.09±0.26	1.29±0.25	0.78 (-0.26 - 1.83)	0.001Ω	F=9.06 P= 0.01*
	Control	0.99±0.14	0.98±0.26	-0.04 (-1.06 - 0.96)	0.22	
Step length (cm)	DNS	51.2±66.26	58.3±64.09	0.10 (-0.90 - 1.12)	0.003Ω	F=18.56 P= 0.001*
	Control	50.30±2.3	51.71±1.3	0.75 (-0.29 - 1.80)	0.36	
Step width (cm)	DNS	15.45±3.54	12.74±3.63	-0.75 (-1.80 - 0.29)	0.01Ω	F= 19.56 P= 0.006*
	Control	17.32±2.41	17.43±2.25	0.047 (-0.96 - 1.05)	0.85	

SD= Standard Deviation, DNS= Dynamic Neuromuscular Stabilization
Ω Significant within-group changes
* Significant between DNS and control groups.

DISCUSSION

The results of the current study indicated that patients with AD could improve balance and gait parameters after 8 weeks of DNS exercises. However, the DNS group showed a large ES in only balance outcome while for gait parameters small to moderate ES was reported. To our knowledge,this was the first study to date that presents comparativefindings to demonstrate the effects of DNS on balance and gait in patients with AD. Therefore, it was difficult to compare our results with previous data in the literature.The result of the current study is in line with Son et al., (2017) and Kim et al., (2017) [12,21]. Son et al., also reported that 4 weeks of DNS exercises are effective to improve the score of gross motor function for standing, walking, and jumping domains in participants with spastic diplegic cerebral palsy[12].Kim et al., assessed the effect of 4 weeks of DNS exercises on balance and walking time in an adolescent with spastic hemiparetic cerebral palsy and found DNS exercises as an effective intervention for improving balance and walking time [20].However, compared to the study of Son et al., the current study showed larger ES for balance. Son et al., assessed balance using Berg balance scale in which the patients should fill out the questionnaire while TUG used in the current study needs participants to walk in a specific distance. The aim of the DNS approach is that every joint position depends on stabilizing muscle function and coordination of both the local and distant muscles to ensure the neutral or centered position of joints in the kinetic chain based on the growth kinematics positions exhibited by healthy infants[19]. Prescribing DNS exercises, the therapist looked for an improvement in the integrated spinal stabilizing system and intraabdominal pressure [19]. Any growth position is an exercise position, but each exercise should follow a series of principles include: restoration of the appropriate respiratory pattern and adjust the intra-abdominal pressure, creating high protection in dynamic movement in the limbs; and ensuring the centrality of all joints[19]. The ultimate strategy is to train the mind to maintain central control, detailed stability, and perfect movement quality that are obtained by the therapist's guidance. In examining the effect of DNS exercises on the balance of patients with AD it can be hypothesized that improving spinal/postural stability and activation of the local spinal stabilizer muscles led to patients having more control on their core and gained balance while waling in the TUG test. Step length is reflective of the time spent instance [22] and is indicative of the ability to bear weight on the stance limb. Stability and weight-bearing on the stance limb are valid predictors of step length[23]. Step width, on the other hand, showed the magnitude of the base of support in individuals' gait [24]. In the current study, GV and SL increased while SW decreased in post-test assessment in AD patients. This means that after 8-weeks of DNS exercises with the aim of postural and spinal/stabilization and activating local stabilizer muscles, the subject's need for a wider base of support decreased, and better controlling of trunk and stabilization of spine led to longer SL and faster GV. To prove this idea, a previous study reported that that spinal stabilization exercise training may be effective in improving selected spatial and temporal parameters of gait as a part of an overall rehabilitation program in individuals with lower-limb loss through the strengthening of the core muscles of the trunk [25]. This study is not without limitations. Low sample size due to lack of accessibility to AD patients, failure to design follow-up assessment to examine the long-term effects of DNS exercises, and lack of another intervention or a placebo group to compare the effectiveness of DNS exercises with other intervention were the major limitations of the current study. To conclude, it seems that DNS exercises can be beneficial to improve balance and gait parameters, in patients with AD. We recommend that researchers designing a similar study with larger sample size, a follow-up assessment, and including another effective intervention to find larger ES.

ACKNOWLEDGMENTS

The authors are grateful to all the participants of the study. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

CONFILICT OF INTEREST

The authors have no conflict of interest to report.

REFERENCES

1. Matthews KA, Xu W, Gaglioti AH, et al. Racial and ethnic estimates of Alzheimer's disease and related dementias in the United States (2015–2060) in adults aged≥ 65 years. Alzheimer's & Dementia. 2019;15(1):17-24.
2. Gholamzadeh S, Heshmati B, Mani A, et al. The prevalence of alzheimer's disease; its risk and protective factors among the elderly population in Iran. Shiraz E-Medical Journal. 2017;18(9):e57576.
3. Thomas VS, Vandenberg EV, Potter JF. Non-neurological factors are implicated in impairments in gait and mobility among patients in a clinical dementia referral population. International journal of geriatric psychiatry. 2002;17(2):128-133.
4. Morris JC, Rubin EH, Morris EJ, et al. Senile dementia of the Alzheimer's type: an important risk factor for serious falls. Journal of gerontology. 1987;42(4):412-417.
5. Nourhashemi F, Andrieu S, Sastres N, et al. Descriptive analysis of emergency hospital admissions of patients with Alzheimer disease. Alzheimer Disease & Associated Disorders. 2001;15(1):21-25.
6. Zhu CW, Scarmeas N, Torgan R, et al. Clinical features associated with costs in early AD: baseline data from the Predictors Study. Neurology. 2006;66(7):1021-1028.
7. Ries JD, Drake JM, Marino C. A small-group functional balance intervention for individuals with Alzheimer disease: a pilot study. Journal of Neurologic Physical Therapy. 2010;34(1):3-10.
8. Arcoverde C, Deslandes A, Moraes H, et al. Treadmill training as an augmentation treatment for Alzheimer? s disease: a pilot randomized controlled study. Arquivos de neuro-psiquiatria. 2014;72(3):190-196.
9. Schwenk M, Zieschang T, Englert S, et al. Improvements in gait characteristics after intensive resistance and functional training in people with dementia: a randomised controlled trial. BMC geriatrics. 2014;14(1):1-9.
10. Kolar P, Kobesova A, Valouchova P, et al. Dynamic neuromuscular stabilization: assessment methods. Recognizing and treating breathing disorders: A multidisciplinary approach. 2014:93-94.
11. Yoon HS, You JSH. Reflex-mediated dynamic neuromuscular stabilization in stroke patients: EMG processing and ultrasound imaging. Technology and Health Care. 2017;25(S1):99-106.
12. Son MS, Jung DH, You JSH, et al. Effects of dynamic neuromuscular stabilization on diaphragm movement, postural control, balance and gait performance in cerebral palsy. NeuroRehabilitation. 2017;41(4):739-746.
13. Shumway-Cook A, Brauer S, Woollacott M. Predicting the probability for falls in community-dwelling older adults using the Timed Up & Go Test. Physical therapy. 2000;80(9):896-903.
14. Ries JD, Echternach JL, Nof L, et al. Test-retest reliability and minimal detectable change scores for the timed "up & go" test, the six-minute walk test, and gait speed in people with Alzheimer disease. Physical therapy. 2009;89(6):569-579.
15. Morio Y, Izawa KP, Omori Y, et al. The relationship between walking speed and step length in older aged patients. Diseases. 2019;7(1):17.
16. Young PMM, Dingwell JB. Voluntarily changing step length or step width affects dynamic stability of human walking. Gait & posture. 2012;35(3):472-477.

17. Davis III RB, Ounpuu S, Tyburski D, et al. A gait analysis data collection and reduction technique. Human movement science. 1991;10(5):575-587.
18. Fernández-González P, Koutsou A, Cuesta-Gómez A, et al. Reliability of Kinovea® Software and Agreement with a Three-Dimensional Motion System for Gait Analysis in Healthy Subjects. Sensors. 2020;20(11):3154.
19. Frank C, Kobesova A, Kolar P. Dynamic neuromuscular stabilization & sports rehabilitation. International journal of sports physical therapy. 2013;8(1):62.
20. Cohen J. Quantitative methods in psychology: A power primer. Psychol Bull. 1992;112:1155-1159.
21. Kim D-H, An D-H, Yoo W-G. Effects of 4 weeks of dynamic neuromuscular stabilization training on balance and gait performance in an adolescent with spastic hemiparetic cerebral palsy. Journal of physical therapy science. 2017;29(10):1881-1882.
22. Perry J, Davids JR. Gait analysis: normal and pathological function. Journal of Pediatric Orthopaedics. 1992;12(6):815.
23. Tokuno CD, Sanderson DJ, Inglis JT, et al. Postural and movement adaptations by individuals with a unilateral below-knee amputation during gait initiation. Gait & posture. 2003;18(3):158-169.
24. Aruin AS, Hanke TA, Sharma A. Base of support feedback in gait rehabilitation. International Journal of Rehabilitation Research. 2003;26(4):309-312.
25. Corio F, Troiano R, Magel JR. The effects of spinal stabilization exercises on the spatial and temporal parameters of gait in individuals with lower limb loss. JPO: Journal of Prosthetics and Orthotics. 2010;22(4):230-236.