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Edorium J Disabil Rehabil 2016;2:124–130.
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ORIGINAL ARTICLE PEER REVIEWED | OPEN ACCESS

Evaluation of dance therapy effects on gait pattern in patients with previous cerebrovascular events: Randomized study results from a single center

Erbil Dursun, Soner Yalcin, Tugba Gokbel, Cagla Karacan, Beril Melina Dursun, Melike Akarsu, Nigar Dursun

ABSTRACT

Aims: As stroke is a complex medical condition involving physical, psychological and cognitive impairments, and also causes restrictions in daily activities and social participation, its rehabilitation is very important, but challenging. Therefore, we aimed to investigate the effects of therapeutic dance programs on walking ability and balance in post-stroke patients, when combined with botulinum toxin A (BTX-A) injections and conventional rehabilitation program. Methods: A total of 51 post-stroke hemiplegic patients treated with BTX-A, who attended the conventional neurological rehabilitation program of the Physical Therapy and Rehabilitation Clinic of Kocaeli University Medical School between November 2014 and December 2015, were included in this prospective, randomized, single center study. Patients were randomized as 1:1 into adapted tango classes (n = 27) and control group (n= 24). Clinical and functional outcomes were evaluated by the Modified Ashworth Scale (MAS), BBS, and Timed Up and Go (TUG) tests. Results: Patients in the tango and control groups were well-matched in age, gender, and stroke side during randomization. There were statistically significant improvements in the tango group in MAS (p = 0.002), in TUG (p<0.001), and Berg Balance Scale (BBS) (p< 0.001) when compared with the control group, respectively (p<0.001, p=0.042, p<0.001). Balance improvement was more prominent in the tango group than in the control group (p= 0.003). Conclusion: Partner adapted tango dance therapy accompanying BTX-A injections may improve postural balance in ambulatory post-stroke patients, who are treated with the conventional rehabilitation program.

Keywords: Botulinum toxin injection, Chronic stroke, Dance, Exercise

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Received: 25 April 2016
Accepted: 19 August 2016
Published: 20 October 2016

How to cite this article

Dursun E, Yalcin S, Gokbel T, Karacan C, Dursun BM, Akarsu M, Dursun N. Evaluation of dance therapy effects on gait pattern in patients with previous cerebrovascular events: Randomized study results from a single center. Edorium J Disabil Rehabil 2016;2:124–130.

Article ID: 100019D05ED2016

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doi:10.5348/D05-2016-19-OA-15

INTRODUCTION

The World Health Organization has reported that every year 15 million people suffer from stroke worldwide, and that it is the second leading cause of disability, after dementia [1]. Similarly, it occupies the third place in the loss of disability adjusted life years (DALY) estimates with a rate of 5.9% in Turkey. The number of deaths attributed to risk factors and burden from stroke, as reflected by loss of DALY is relatively high in Turkey [2].

Stroke is not only a complex medical condition involving physical, psychological and cognitive impairments, but also restricts daily activities and social participation. Therefore, its rehabilitation is very important, but challenging [3]. Although there are exercise interventions targeted at improving mobility, balance, and quality of life in a post-stroke patient, some programs may not meet general acceptance, because they are severe and require high levels of cooperation from patients who are already discouraged about how to cope with life, and feel insecure about the future [4]. Moreover, to achieve targets set for individual patients, post-stroke rehabilitation programs should be planned for long-term, and may require different methods for individual patient needs. In order to provide patient compliance and complete involvement in rehabilitation programs, these programs should be both motivational, and entertaining [4].

In patients with chronic stroke, spasticity is one of the major challenges in rehabilitation efficacy. In addition to standard conservative measures, physical agents, oral antispastic agents, and neuromuscular blockade by local injections of botulinum toxin A (BTX-A) are administered to increase mobility and range of motion in post-stroke patients, to help reorganize their daily life activities sooner [5]. Although the use of BTX-A on the lower extremities has not been studied as extensively as its use on the upper extremities, reported outcomes indicated that BTX-A injections are beneficial in patients with a stiff knee pattern and ankle plantar flexor spasticity, and thus facilitating physiotherapy and encourage functional improvements [6– 8].

More than two decades ago, dance therapy was initiated to be used empirically to augment movement strategies in the elderly in addition to traditional exercise programs. Favorable outcomes of the new exercise programs encouraged healthcare professionals to apply this new approach in patients with Parkinson's disease (PD) as a part of their conventional rehabilitation programs. Scientific effects of dancing on functional mobility and neurological activation were evaluated in the mid-2000s in PD patients [9, 10]. In 2005, Jacobson et al. reported greater balance and complex gait task improvements in elderly patients who danced Argentine tango, compared to a group who walked for exercise purposes [9, 10]. In studies performed until recent years, Argentine tango was compared with American ballroom dance (i.e Waltz, Foxtrot) [11] or jazz dance and merengue, in PD patients or subacute stroke patients in a rehabilitation hospital setting [12]. Hackney et al. (2009) reported in their study comparing Argentine tango and American ballroom dance on PD patients that tango involved flexible, improvisational step patterns composed of small step elements, spontaneous multi-directional perturbation for patients and rhythmic variation. However, the strict syllabus of the step patterns in Waltz/Foxtrot complicated step elements more with little rhythmic variation or improvisations for patients. They concluded that Argentine tango improved deficits of PD more than Waltz/Foxtrot, but both dance styles were beneficial in maintaining balance and motion [11]. Recently, promising outcomes obtained in balance, gait and mobility functions on PD patients who have attended Argentine tango classes have inspired clinicians to introduce dance classes into conventional rehabilitation programs of stroke patients [12, 13]. Hackeny et al. conducted dance therapy studies both on PD and chronic stroke patients, and reported that the intersecting point of these two diseases were postural instability and gait deficits, both of which caused an increased risk of falling [11].

In the present study, we aimed to investigate whether Argentine tango classes introduced in combination with conventional rehabilitation program and BTX-A injections would improve balance and walking ability in patients who experienced a stroke at least six months before.

MATERIALS AND METHODS

Participants

A total of 61 post-stroke adult patients (18–60 years of age) who had a cerebrovascular event with the shortest duration of six months, with Brunnstrom stage ≥3, and who were ambulatory without assistance or aided by crutches or a cane, and were scheduled for the conventional neurological rehabilitation program after BTX-A injections in plantar flexor muscles at IREM, were enrolled in the present study. Patients who had cognitive dysfunctions affecting participation in the study, and who had accompanying medical diseases interfering with participation, were excluded from the study. Cognitive function was assessed using Mini Mental State Examination Test which was routinely applied by the special senior trainer in the center. Patients with a lower score of 24 were excluded from the study.

All patients were informed about the study, and subjects who gave written informed consents were enrolled in the study. The study was approved by the Local Ethics Committee of Kocaeli University Medical School (KOU/ KAEK 2014/297).

Enrolled subjects were randomized as 1:1 into the tango (n= 27) and control (n= 24) arms. A computer

assisted randomization list was created using 6 as block size, with respect to this 27 patients were assigned to tango and 24 to control groups as shown in flow chart. The randomized groups and study flow-chart are shown in Figure 1.

Botulinum toxin A (BTX-A) injections

Izmit Rehabilitation Center (IREM) is a connected setting of occupational therapy school, physical medicine and rehabilitation (PMR) department, and outpatient rehabilitation center of Kocaeli University. The neurorehabilitation team is composed of a senior physical medicine and rehabilitation specialist, occupational therapists, physiotherapists, graduates from the faculty of sports sciences studying for their master's degrees in occupation and recreational therapy. Each healthy partner who attended tango classes accompanied one of the patients.

As IREM is a referral center, the majority of applicants were patients who required both medical and occupational therapies to improve their active daily lives (ADLs). BTX-A injections were applied according to the degree of spasticity and duration of chronicity of the event, by a senior PMR specialist after muscle selection, doses, and dilution for BTX-A injections were individualized for each patient considering detailed clinical examination, severity of spasticity, gait pattern, and treatment goals. Our previous clinical experience demonstrated that individualization of BTX-A treatment was better than a standard treatment schedule, because the degree of spasticity might differ between patients, and the physician could achieve the best clinical response at the minimal effective dose. Moreover, we observed that such an approach was more easily accepted by patients. In this rehabilitation setting, BTX-A treated patients were routinely scheduled for a conventional rehabilitation program within one week to 10 days after BTX-A injection. All patients enrolled in this clinical trial received BTX-A injections to plantar flexor muscle complex, while 20 patients in the tango group and 15 in the control group received multilevel injections by the same senior PMR specialist. BTX-A was injected into the target muscles under the guidance of electrical stimulation.

Therapy schedules in groups

One week to 10 days after BTX-A injection both the patient in tango and control groups received a standard 45-minute rehabilitation program five times in a week for three weeks. Conventional rehabilitation therapy regimens consisted of task oriented exercises such as walking over obstacles and slaloming, strengthening of most frequently impaired muscle groups that affect body movements, while stretching targeted the most commonly shortened muscle group affecting balance and walking [14–16]. Patients in the tango group attended their classes, whereas patients in the control group received

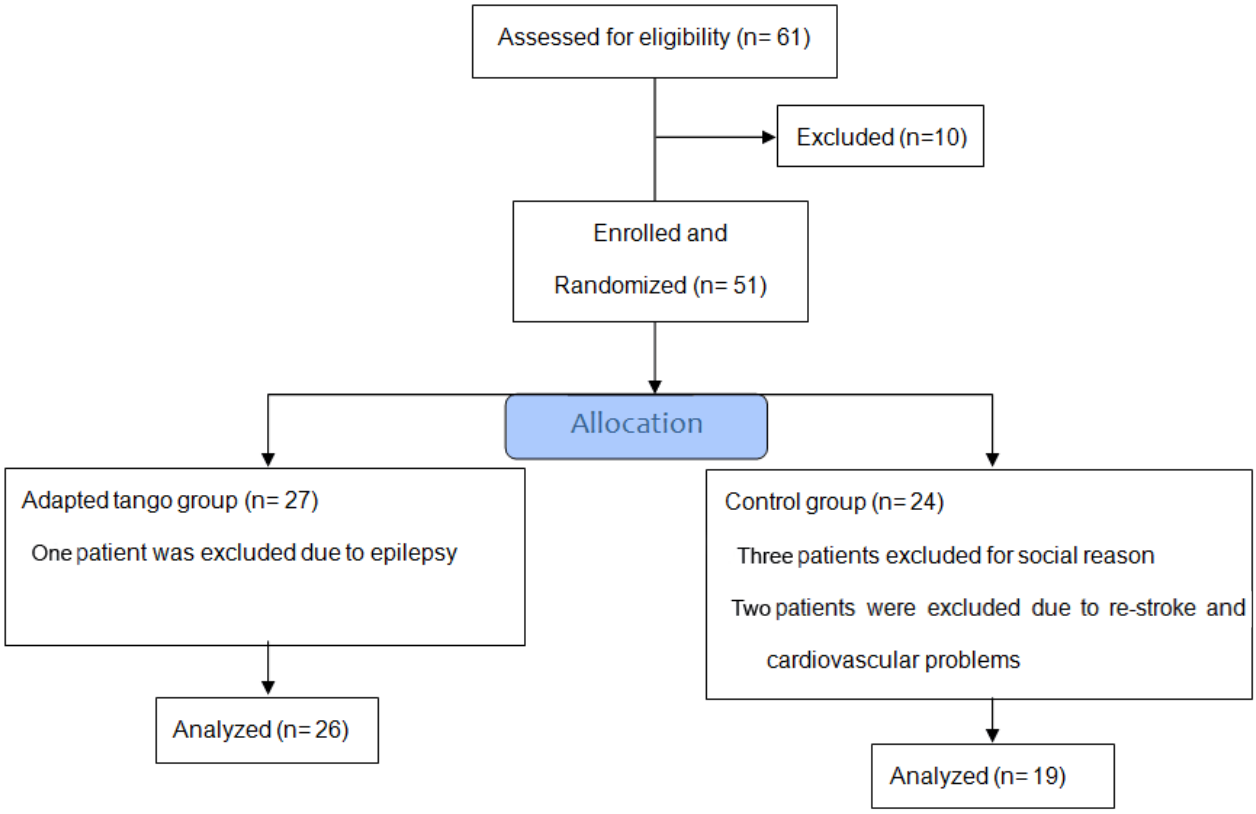

Figure 1: Flow chart of the study.

exercises for an additional 30 minutes according to their specific needs, i.e. more sets of exercises in balance or gait improvements.

After a 45-minute conventional neurological rehabilitation program, patients in the tango group were taken to the dance room with their teachers together with partners who already knew the daily exercise program, for an additional 30 minutes. Tango dance movements were selected as the basic dance steps and they were adapted by the person who was both a medical doctor and tango trainer according to treatment goals. The dance movements were aimed to increase abilities mainly in stepping forward, transferring body weight from one foot to another, and exercising basic arm movements. Our trainer consulted both literature information and clinical conditions of participants during modifications of tango dance steps such as *molinete*, *cruzada, ochos, figure 8s, corte, amargue, parade, mordita and barrida* as well as some adornment movements [17]. Selected movements were first demonstrated to the class, after which participants were allowed to try by themselves for five minutes. After these five minutes partners held hands of each participant to provide balance and performed the movements together until it was well established in the participant (partners were always the leaders). In both groups, participants were allowed to sit down for a while when they felt tired. It was observed that none of our participants had to discontinue tango class or additional conventional rehabilitation sessions because of extreme fatigue.

Clinical and functional assessment

The baseline and posttreatment muscle tone was evaluated using the modified Ashworth Scale (MAS) in each patient [18]. The Brunnstorm approach was used in the evaluation of motor recovery after the stroke independent ambulatory with stage 3, hence more recoveries were included in the study. The functional mobility and balance ability of all patients were evaluated using Berg blance scale (BBS) [19], and timed up and go (TUG) tests before and after treatment. In the TUG test patients were requested to stand up from a chair, walk for three meters, turn around, walk back to the chair, and sit down again as quickly as possible. In the study, the mean of three trials was calculated and recorded for each participant [20].

The Berg balance scale (BBS) is a widely used clinical test to evaluate a person's static and dynamic balance abilities, among people with impairment in balance function. Berg balance scale is generally considered to be the gold standard of functional balance test, and it is a valid instrument used for evaluating the effectiveness of interventions and for quantitative descriptions of functions in clinical practice and research. The test takes 15–20 minutes and comprises a set of 14 simple balance related tasks, ranging from standing up from a sitting position, to standing on one foot. The degree of success in achieving each task is given a score of zero (unable) to four (independent), and the final measure is the sum of all of the scores. The highest score is 56, and score 0 to 20 indicates a balance disorder; score 21 to 40 indicates an acceptable balance disorder; while score 41 to 56 indicates a good balancing ability. [21].

Statistical analysis

Demographic results were descriptive, and expressed as percentage or mean±SD. Comparison of pre- and post-treatment MAS, BBS and TUG test results within each group were performed using the paired samples *t* test. Comparisons between the tango and control groups were performed by the independent *t* test. For statistical analysis, MAS scores were derived as 0=0, 1=1, +1=2, 2=3, 3=4, and 4=5. Comparison between tango and control groups were performed by independent t or χ^2 tests. All analysis were made using a confidence interval of 95% and a significance level of <0.05.

RESULTS

A total of 61 post-stroke hemiplegic patients were screened, 51 patients each received BTX-A injections to the plantar flexor muscles and scheduled for conventional neurological rehabilitation program in the Physical Therapy and Rehabilitation Clinic of Kocaeli University Medical School (Izmit Rehabilitation Center) between November 2014 and December 2015 were included in this prospective, randomized, single center study. Of 10 patients who dropped out, 6 patients had cognitive disorders and 4 patients had accompanying systemic diseases. Participants who fulfilled inclusion criteria were randomized 1:1 to the tango dance and control groups. The mean age of participants in the tango and control groups was 47.15±15.5, and 49.21±12.7 years, with a female/male ratios of 10/16 and 7/12, respectively. Both groups were well-matched in age, gender, stroke side, and functional assessments at the baseline (Table 1). There was no statistically significant difference in multilevel BTX-A injections between the groups (χ^2 test; p=0.584). The mean disease durations were 38.96±35.29 months and 41.87±31.68 months for the tango and control groups, respectively (p= 0.257).

After the designated rehabilitation programs, functional assessments indicated significant improvements in MAS, TUG and BBS in both groups. However, improvements in the tango dance group were more prominent than in the control group, respectively (all p values <0.05) (Table 2).

The average amount of change in TUG test for tango and control groups were 4.98±7.1 and 2.65±5.3, respectively (p= 0.421). Average amount of change in

BBS for tango group (3.84±3.3) was significantly greater than that of the control group (2.35±1.6) (p= 0.003) (Figure 2).

DISCUSSION

Our study results indicated that tango dance therapy may be combined with conventional rehabilitation programs of patients who had stroke at least six month ago, and may easily be accepted as an effective, non-pharmacological, and motivational way for rehabilitation by patients. To the best of our knowledge, this is the first prospective study performed in literature, in chronic post-stroke patients who received BTX-A injections in their lower extremities and then additional adapted tango classes on routine conventional rehabilitation program at an outpatient setting.

Similar to Parkinson disease patients or frail elderly patients, one of the ADL has also been reported to be walking in post-stroke patients for their daily life activities and social participations. However, ambulation may be difficult after stroke due to major problems such as ankle plantar flexion and inversion, stiff knee pattern. There is a limited number of studies in literature about BTX-A injections on lower limb spasticity in chronic stroke patients. However, reported outcomes indicate a small statistically significant increases in gait velocity, improvements in motion ability, and kinematic gait parameters [5, 6, 22, 23]. In our center, BTX-A injections were proposed to selected patients in addition to the conventional rehabilitation program by a senior PMR specialist, and if he/she agreed on BTX-A as an add-on treatment, the individualized program was scheduled and performed by the experienced PMR specialist.

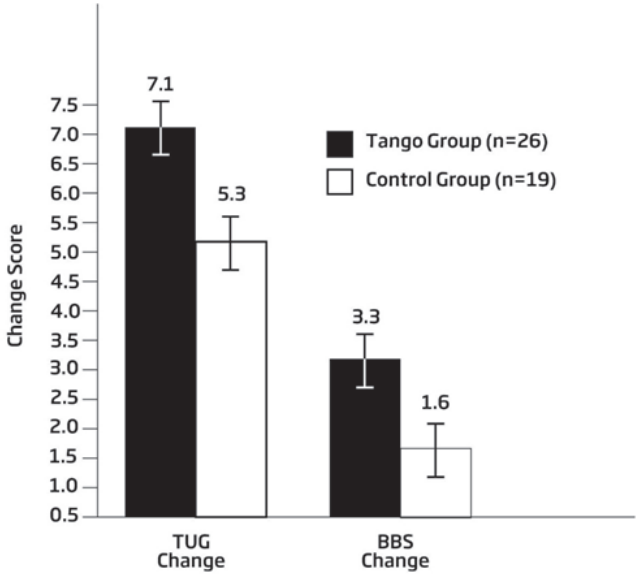

Figure 2: Change scores in timed up and go (TUG) and Berg balance scale (BBS).

Table 1: Baseline clinical parameters

	Tango group (n= 26)	Control group (n= 19)	*p*
Age (years)	47.15±15.5	49.21±12.7	0.557
Gender (F/M)	10/16	7/12	0.581
Side of Stroke	12/14	13/6	0.119
Mean duration of stroke (months)	38.96±35.29	41.87±31.68	0.257
Baseline MAS	3.23±0.44	3.16±0.4	0.229
Baseline TUG	23.79±21.7	23.16±10.1	0.499
Baseline BBS	44.62±8.1	42.27±9.4	0.820

MAS Modified Ashworth Scale, TUG Time Up and Go test, BBS Berg Balance Scale.

Table 2: Post-treatment assessments of groups

	Tango group (n= 26)	Control group (n= 19)	*p*
Modified Ashworth Scale			
Before	3.23±0.44	3.16±0.14	0.229
After	1.58±0.6	1.68±0.6	0.683
P	0.002	<0.001	
Time Up and Go Test			
Before	23.79±21.7	23.16±10.1	0.499
After	18.81±15.9	20.51±10.2	0.950
P	<0.001	0.042	
Berg Balance Scale			
Before	44.62±8.1	42.27±9.4	0.820
After	48.19±6.2	44.57±9.4	0.142
P	<0.001	<0.001	

In literature, dance therapy has a very recent medical therapeutic history, which was first initiated in frail elderly patients [11]. As favorable outcomes were reported, it was adapted to the rehabilitation programs of Parkinson disease by various investigators [9–17]. Hackney et al. [13] worked on a 73-year-old patient who had stroke 13 years ago, and who had spastic hemiplegia, with visual impairment and many comorbidities. The investigators reported that the patient improved in all predefined parameters measured by TUG and BBS after approximately 20 hours of adapted tango classes, and he reported that he wished the classes would continue. In the present study, we adapted tango dance classes because Parkinson disease and stroke were intersecting

both in postural instability and gait deficits. We could not collect data about gait improvements by the gait analysis system (Vicon Movement Systems, Oxford, UK), because it was not repaired for a long time. However, statistically significant improvements were achieved in muscle tone, walking ability, and balance in the tango and control groups (Table 2). The change score between groups was statistically significantly improved only in BBS, whereas the score was not significant for (p = 0.421). None of the participants missed their tango classes. This might be because, tango classes were performed after conventional rehabilitation sessions and it was one of the shortest ones (a total of 7.5 hours in three weeks) found in literature [11, 13]

There are limitations in our study. Firstly, the small sample size may have caused type II error, which may prevent healthy evaluation of significance in the "after scores". Secondly, we should have applied one of the health related life quality questionnaires to determine whether there were any improvements in their psychological conditions. Now, we can only talk about our clinical observations, that our participants had a tango dance performance to the local public at the Suleyman Demirel Cultural Center, and that it was in the local newspapers. All of the participants were very proud for their achievements. Another limitation is that we should have supported the TUG data with the gait analysis system, so as to have more detailed data. That notwithstanding, this project is still ongoing at our center to increase the sample size by using more objective evaluation tools.

In conclusion, we believe that the combination of individualized BTX-A injection with adapted Argentine tango classes may increase efficacy of the conventional rehabilitation therapy in chronic post-stroke patients. Furthermore, studies with large sample sizes and longer follow up periods will shed more light on this relatively newly developing field of rehabilitation.

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Acknowledgements
We would like to thank Evin ISGOR, MD (Medical writer, Istanbul/Turkey) for the language review and editorial supervision.

Author Contributions
Dursun Erbil – Substantial contributions to conception and design, Acquisition of data, Analysis and interpretation of data, Drafting the article, Revising it critically for important intellectual content, Final approval of the version to be published
Yalcin Soner – Substantial contributions to conception and design, Acquisition of data, Revising it critically for important intellectual content, Final approval of the version to be published
Gokbel Tugba – Acquisition of data, Revising it critically for important intellectual content, Final approval of the version to be published
Cagla Karacan – Acquisition of data, Revising it critically for important intellectual content, Final approval of the version to be published
Beril Melina Dursun – Acquisition of data, Revising it critically for important intellectual content, Final approval of the version to be published
Melike Akarsu – Acquisition of data, Critical revision of the article, Final approval of the version to be published
Dursun Nigar – Substantial contributions to conception and design, Acquisition of data, Analysis and interpretation of data, Drafting the article, Critical revision of the article, Final approval of the version to be published

Guarantor
The corresponding author is the guarantor of submission.

Conflict of Interest
Authors declare no conflict of interest.

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