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Review Article

Dual Task Training in Patients with Stroke for Improving Balance and Gait: A Systematic Review

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ABSTRACT

Introduction: Walking while performing a cognitive task (i.e. dual-task) disturbs the control of balance and hence interfere with gait in stroke individuals. Dual Task training is said to improve the same. However, it is necessary to establish this fact through the in depth study of available literature.
Methodology: A literature search was performed with help of PubMed to select the studies related to dual task training on balance and gait. The inclusion criteria were prospective or retrospective cohort studies, studies that included only participants with stroke leading to hemiparesis and/or along with healthy participants as control group and studies that include dual task training on balance and gait. Two independent investigators assessed the studies based on inclusion and exclusion criteria. The studies were thoroughly evaluated with respect to dual task training on balance and gait.
Results: With the help of given keywords, abstracts of 25 studies were retrieved. After initial screening 12 studies were selected for in depth analysis. Dual task training along with different treatment approaches was investigated and outcome measures like Berg Balance Scale, Gait Variables, Functional Reach Test, Time Up and Go Test and 10 Meters Walk Test was measured.
Conclusion: From this study it can be concluded that dual task training was found to be effective in improving functional performance of the stroke patients.

Key words: dual task training, balance, gait and stroke.

BACKGROUND

Stroke is a disease caused by a lack of blood supply to the brain following ischemia or hemorrhage. The reduced motility following stroke results in a body imbalance that appears as asymmetric posture, proprioception disorder, and abnormal muscle tone that lead to the degeneration of balancing ability. [1] It causes loss of positional control that leads to instability, which in turn brings about reduced balancing ability, concentration difficulty, and decreased independence in activities of daily living (ADLs). [2]

Cerebrovascular disease-related mortality rates have been increasing, and 1 out of every 4 cerebrovascular disease patients dies within a month after the onset of disease1). Among the surviving patients, 15–30% becomes severely handicapped, and 40% are left with functional deficits resulting in problems with the major components of functional independence: motor, sensory, and cognitive functions. [3] Daily living requires balance and walking ability while performing other tasks. Thus, balancing and gait training for hemiplegic stroke patients should reflect the motor skills and cognitive function required in daily living dual tasks. [4]

Dual-task training is a training in which two or more tasks are performed at the same time continuously. However, dual-task training allows coordination of various tasks, as one can perform more than two tasks at the same time[2].Dual tasks fall into two main groups: motor dual tasks, which require performance of a motor task and a postural control task at the same time; and cognition dual task which require performance of a cognition task and postural control task at the same time. Both types of dual task are noted as ways of training patients with neurological damage to recover their motor control ability. [4]

Cognitive-motor and motor dual tasks play important roles in daily life: walking while talking, using a mobile phone, carrying a bag or watching traffic. Previous studies have indicated, however, that performing two tasks simultaneously may negatively impact gait performance. Dual task interference impacting gait performance has been observed not only in healthy subjects, but also in subjects with neurological disorders. [5]

RESEARCH QUESTION – Is Dual Task Training best treatment intervention available in the literature for balance and gait rehabilitation in patients with stroke?

AIM: To provide best possible evidence for most effective dual task training approach for balance and gait rehabilitation in patients with Stroke.

OBJECTIVES:

1. To explore the literature related to Dual Task Training for Balance and Gait Rehabilitation, available in last 10 years.
2. To describe the Dual Task Training approaches used in various research studies.
3. To describe the outcome measures used in various studies for measuring the effectiveness of an intervention.
4. To analyze the studies for details about the intervention and its effectiveness.

METHODOLOGY

All studies related to Dual Task Training in patients with stroke were sought. To achieve this, a systematic literature search was conducted in March 2018 through the most commonly used search engine Pubmed. Full text articles from peer-reviewed journals were included. Intervention based studies in the form of Clinical Trials, Experimental Studies, Quasi experimental studies, RCTs were included. Due to Language and appropriate translation issue, only studies published in English language were considered. A combination of the following keywords and MeSH terms were used: Dual Task Training, Balance, Gait, and Stroke.

Study selection and data extraction:

The Inclusion criteria were 1) Prospective or retrospective cohort studies, 2) studies that included only participants with stroke leading to hemiparesis and/or along with healthy participants as control group and 3) studies that include Dual Task Training. The exclusion criteria were if their population of interest also included patients with other neurological conditions and studies in any language other than English. To begin with, two reviewers (SR, SG) independently read the titles and/or abstracts of the identified studies with respect to the inclusion and exclusion criteria. Irrelevant studies were removed from the list. Potentially eligible studies were read fully by both reviewers and their suitability for inclusion was independently determined by both SR and SG. Disagreement was resolved by consensus.

Types of outcome: The outcomes were Auditory Stroop test, Stepping down test, Cadence, Stride time, Stride length, Berg balance scale, Five Times Sit-to Stand Test, Functional Reach Test, 10-Meter Walk Test, Timed Up and Go Test, . Figure-of-8 Walk Test (F8WT) and Functional Gait Assessment.

List of abbreviations: BMI-Body Mass Index, MMSE- Mini Mental State Examination, BBS- Berg Balance Scale , TUG- Time Up And Go Test, FGAS – Functional Gait Assessment Scale, FRT- Functional Reach Test , DTT- Dual Task Training, ADL- Activities of daily living, COP- Center Of Pressure, 10MWT- 10-Meter Walk Test, and F8WT-Figure-of-8 Walk Test .

Data Extraction:

Preliminary information was extracted from the each eligible study which included: study type and setting, patient demographics (age, gender) and clinical characteristics including relevant inclusion and exclusion criteria, dual task training , and the task given to the participants was noted. In case of a query about the study, authors were contacted by email for clarification. Each study was read in details by both authors separately.

RESULTS

Flow of the studies through the review

Table 1: Patient characteristics and intervention described in the articles included in review.

STUDY	TYPE OF PATIENTS	NO. OF PATIENTS	INTERVENTION
1. Wing-Nga Chan (2017)	Stroke Duration: six or more months	26 patients Tai Chi (*n*= 9), conventional exercise (*n* = 8), and control (*n* = 9) groups.	Tai Chi training on dual-tasking performance. 12 weeks
2. Yan-Ci Liu (2017)	Stroke	Participants (n = 28) were randomly assigned to (CDTT), (MDTT), or (CPT) group.	**CDTT or MDTT group** practiced the cognitive or motor tasks respectively during walking. **CPT group** received strengthening, balance, and gait training. Duration: 30 min/session 3 sessions/ week for 4 weeks.
3.Kyoung Kim (2016)	Stroke Duration: 6 months	20 stroke patients were divided into the experimental (n=10) and control (n=10) groups	**Both groups** underwent neuro developmental treatment. **The experimental group** additionally underwent aquatic dual-task training for 30 minutes a day, 5 days a week, for 6 weeks.
4.Hyunseung Kim (2015)	Chronic stroke. Duration: 6 months	40 chronic Stroke. patientswere randomly divided into two groups of 20 subjects each.	**The experimental group** performed virtual dual-task treadmill training using a video recording for 30 minutes per session, three times a week for 4 weeks, **Control group** performed only treadmill training for 30 minutes per session, three times a week for 4 weeks. A video recording was performed in a large supermarket, and the subjects could walk at their favorable speed on a treadmill.
5. Gui bin Song (2015)	Stroke Onset period: 14.30 ± 3.40 months	Forty stroke patients were divided into a dual-task training group (N = 20) and a single task training group (N = 20) randomly.	**Single-**task **training group** stood in a comfortable position, faced a therapist, then threw a Swiss ball back and forth. They then performed balance training in which they raised and lowered their ankles while facing forward or moved objects from one table to another. 2. **The DTG** performed dual tasks, which involved performing a task on an unstable surface using a balance pad. Duration: 30 min per day, five times per week, for eight weeks
6. Ki Hun Cho (2015)	Chronic stroke patients . Duration:6 months post stroke	22 patients were randomly assigned to the VRTCL group (11 patients) or control group (11 patients)	All subjects participated in the standard rehabilitation program that consisted of physical and occupational therapies. **VRTCL group** participated in the VRTCL for 4 weeks (30 min per day and five times a week), **Control group** participated in virtual reality treadmill Training.
7. Jun Hwan Choi (2015)	subacute post stroke. Duration: within 3 months	Twenty patients (12 males and eight females) participants were randomly assigned to one of two groups, the dual-task group (n=10) or the control group (n=10)	Dual task training
8. Ho-Jung An(2014)	chronic stroke patients.	33 outpatients	Dual task gait training for 30 minutes per day, three times a week, for eight weeks
9. GyeYeop Kim (2014)	Stroke. Disease duration was 16.6 months in the DT group and 19.3 months in the ST group.	20 patients	**All participants** were receiving a traditional rehabilitation program 5 days a week. Dual-task **and single-**task training were additionally performed for 4 weeks, 3 days a week.
10.Wonjae Choi (2014)	Chronic stroke.	37 subjects randomly allocated to the dual-task group (n=19) and the single-task group (n=18)	**The** dual-task **group** performed a cognitive-motor dual-task in which they carried a circular ring from side to side according to a random auditory cue during treadmill walking. **The single** task **group** walked on a treadmill only. All subjects completed 15 min per session, 3 times per week, for 4 weeks with conventional rehabilitation 5 times per week over the 4 weeks.
11. Donghoon Kim (2013)	Chronic stroke patients. Duration: 6 months	38 patients who were divided into two groups of 13 patients each and one group of 12 patients	Dual-task training for 30 minutes per session, three times a week, for eight weeks
12. Yea-Ru Yang (2007)	Chronic stroke. Duration:1 year	25 subjects randomized into a control group (n=12) or experimental group (n=13).	**Control group** did not receive any rehabilitation training. **Experimental group** underwent a 4-week ball exercise program.

Table 2: Quality of Study included in review according to PEDro.

Study	Eligibility criteria	Random allocation	Concealed Allocation	Groups Similar at baseline	Participant blinding	Therapist blinding	Assessor blinding	<15 % drop outs	Intention- to-treat analysis	Between group difference reported	Point estimates and variability reported	PEDro score	Grade
1. Wing-Nga Chan (2017)	Y	Y	N	N	N	N	Y	Y	Y	Y	Y	7	high quality
2. Yan-Ci Liu (2017)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10	high quality
3.Kyoung Kim (2016)	N	N	N	Y	N	N	N	Y	Y	Y	Y	5	fair quality
4.Hyunseung Kim (2015)	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	7	high quality
5. Gui bin Song (2015)	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	7	high quality
6. Ki Hun Cho (2015)	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	9	high quality
7. Jun Hwan Choi (2015)	Y	Y	N	N	N	N	N	Y	Y	Y	Y	6	high quality
8. Ho-Jung An (2014)	N	Y	N	N	N	N	N	Y	Y	Y	Y	5	fair quality
9. GyeYeop Kim (2014)	Y	Y	N	N	N	N	N	Y	Y	Y	Y	6	high quality
10.Wonjae Choi (2014)	Y	Y	N	N	N	N	Y	Y	Y	Y	Y	7	high quality
11. Donghoon Kim (2013)	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	8	high quality
12. Yea-Ru Yang (2007)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	10	high quality

The total numbers of records identified by the search of PubMed were 23. After initial screening of titles and abstracts,4 studies were excluded (2 because – it was a observational study, 1 because – patients with Parkinsonism were included, 1 because- it was a case series). After full text review, of the remaining 18 studies, 6 studies were excluded because they were not related to Balance and Gait Function. Therefore, 12 studies were included in the review.

Table 3: Effects of Dual Task Training in Patients with Stroke.

<table>
<tr><th>Study</th><th>No Of Stroke Patients</th><th>Outcome Measure</th><th>Mean±SD</th><th>Conclusion</th></tr>
<tr><td>1. Wing-Nga Chan (2017)</td><td>26 subjects</td><td>1. Berg Balance Scale
2.Functional Reach Test
3.Time Up And Go Test</td><td>
<table>
<tr><th></th><th>Tai Chi (n = 9)</th><th>Conventional exercise (n = 5)</th><th>Control (n = 9)</th><th>p value</th></tr>
<tr><td>BBS score</td><td>51.0 ± 2.9</td><td>50.3 ± 3.2</td><td>54.2 ± 1.7</td><td>0.074</td></tr>
<tr><td>Functional reach (cm)</td><td>23.9 ± 3.7</td><td>23.9 ± 8.3</td><td>32.1 ± 9.0</td><td>0.133</td></tr>
<tr><td>TUGT (sec)</td><td>14.5 ± 4.6</td><td>12.2 ± 2.1</td><td>12.3 ± 5.1</td><td>0.661</td></tr>
</table>
</td><td>These results suggest a beneficial effect of Tai Chi training on cognition among stroke survivors without compromising physical task performance in dual-tasking. The effect was better than the conventional exercise group</td></tr>
<tr><td>2. Yan-Ci Liu (2017)</td><td>28 subjects</td><td>1. Gait Speed
2.Cadence
3.Stride Length
4. Stride Time</td><td>
1. Cognitive dual task gait performance after different training protocols.
<table>
<tr><th></th><th colspan="2">CPT group (n = 10)</th><th colspan="2">CDTT group (n = 9)</th><th colspan="2">MDTT group (n = 9)</th></tr>
<tr><td></td><td>pre</td><td>Post</td><td>Pre</td><td>post</td><td>pre</td><td>Post</td></tr>
<tr><td>Speed (cm/sec)</td><td rowspan="2">62.1 ±19.9</td><td>60.1 ±20.7</td><td rowspan="2">56.4 ±18.0</td><td>63.4 ± 20.6</td><td rowspan="2">62.4 ± 13.8</td><td>63.8 ± 13.7</td></tr>
<tr><td>Change value</td><td>−2.0 ± 9.4</td><td>6.9 ± 11.1</td><td>1.4 ± 4.0</td></tr>
<tr><td>Cadence</td><td>83.6 ±</td><td>83.7 ±</td><td>81.2 ±</td><td>86.1 ±</td><td>93.7</td><td>93.9 ±</td></tr>
</table>
</td><td>It seems that CDTT improved cognitive dual task gait performance and MDTT improved motor dual task gait performance although such improvements did not reach significant group difference.</td></tr>
</table>

(step/min)	14.6	14.6	13.5	12.9	± 11.7	10.8
Change value		0.1 ± 3.9		4.8 ± 10.5		0.2 ± 3.2
Stride time (sec)	1.47 ± 0.25	1.42 ±0.19	1.52 ± 0.27	1.43 ± 0.22	1.30 ± 0.16	1.29 ± 0.14
Change value		−0.05 ±0.15		−0.09 ± 0.20		−0.01 ± 0.06
Stride length (cm)	83.7 ±18.7	85.3 ± 17.6	82.2 ±20.2	88.2 ⍰± 21.4*	80.2 ± 17.2	83.3 ± 17.5
Change value		1.6 ±6.3		5.9 ⍰± 5.9		3.1 ± 3.7

Therefore, different types of dual task gait training can be adopted to enhance different dual task gait performance in stroke.

2. Motor dual task gait performance after different training protocols

	CPT group (n = 10)		CDTT group (n = 9)		MDTT group (n = 9)	
	pre	Post	Pre	post	pre	Post
Speed (cm/sec)	59.4 ± 24.5	68.7 ± 24.5	55.6 ± 14.7	61.8 ± 21.8	57.1 ± 12.0	62.7 ± 12.5
Change value		9.3 ±10.5		6.2 ± 10.5		5.6 ± 2.6
Cadence (step/min)	84.9 ± 15.9	89.9 ± 15.9	84.9 ± 12.1	83.5± 21.8	91.4 ± 9.5	92.1 ± 9.1
Change value		5.0 ± 6.8		−1.4 ± 16.0		0.7 ± 1.9
Stride time (sec)	1.46 ± 0.27	1.37 ± 0.25	1.43 ± 0.21	1.40 ± 0.24	1.33 ± 0.13	1.31 ± 0.13
Change value		−0.09 ± 0.14		−0.03 ± 0.15		−0.01 ± 0.03
Stride length (cm)	82.0 ± 20.1	91.0 ± 19.7	80.8 ± 14.8	83.7 ± 17.8	76.5± 17.0	82.7 ± 16.9
Change value		9.1 ± 11.7		3.0 ± 6.4		6.2 ± 2.8

3. Single walking gait performance after different training protocols

	CPT group (n = 10)		CDTT group (n = 9)		MDTT group (n = 9)	
	pre	Post	Pre	post	pre	Post
Speed (cm/sec)	71.1 ± 20.8	73.7 ± 23.8	70.6 ± 17.7	74.9 ± 20.7	71.8 ± 10.6	72.8 ± 9.8
Change value		2.7 ± 6.1		4.3 ± 6.6		0.9 ±2.3
Cadence (step/min)	90.9 ± 13.3	89.7 ± 15.2	90.31 ± 10.9	94.6 ± 10.9	96.3 ± 8.4	93.8 ± 6.6
Change value		−1.1 ± 3.2		4.3 ± 6.1		−2.5 ± 3.1
Stride time (sec)	1.35 ± 0.22	1.27 ± 0.20	1.35 ± 0.17	1.29 ± 0.16	1.25 ± 0.10	1.28 ± 0.10
Change value		−0.08± 0.27		−0.06 ± 0.11		0.03 ± 0.03
Stride length (cm)	93.5 ±16.29	97.6 ± 19.1	94.1 ± 17.8	95.1 ± 20.1	90.6 ± 14.8	94.4 ± 13.6
Change value		4.1 ±7.4		1.0 ± 5.5		3.8 ± 3.8

3.Kyoung Kim (2016)	20 subjects	1.Berg Balance Scale 2. Functional Reach Test 3.10 Meter Walk Test 4.Time Up And Go Test	(see table below)	Our results showed that aquatic dual task training has a positive effect on balance and gait in stroke patients.

	Group	Pre	Post	D-Value
BBS(score)	EG	41.8 ± 1.6	44.4 ± 1.4	2.6 ± 1.5
	CG	39.4 ± 2.2	40.2 ± 1.9	0.8 ± 1.1
FRT(cm)	EG	19.5 ± 1.7	22.0 ± 1.3	2.5 ± 1.5
	CG	19.7 ± 1.2	20.1 ± 0.9	0.4 ± 0.9
10MWT(sec)	EG	15.9 ± 1.4	12.9 ± 1.9	−3.0 ± 1.4
	CG	15.6 ± 1.5	15.1 ± 1.1	−0.5 ± 0.8
TUGT(sec)	EG	22.9 ± 1.3	20.1 ± 1.9	−2.8 ± 1.3
	CG	20.4 ± 1.0	20.1 ± 1.1	−0.3 ± 0.9

4.Hyunseung Kim (2015)	40 subjects	1. Gait Speed 2.Cadence 3. Stride length	(see table below)	Our findings suggest that virtual dual task treadmill training using a video recording can improve the gait parameters of chronic stroke survivors.

		Experimental group (n=20)	Control group (n=20)
Gait speed (m/s)	Pre	0.8 ± 0.3	0.8 ± 0.4
	Post	1.0 ± 0.3	0.9 ± 0.3
	change	0.2 ± 0.2	0.1 ± 0.1
Cadence (step/min)	Pre	88.5 ± 25	89.3 ± 23.6
	Post	106.2 ± 27.2	100.0 ± 17.7
	change	17.9 ± 9.0	10.7 ± 11.5
Stride length (cm)	Pre	55.6 ± 10.3	104.8 ± 16.8
	Post	57.4 ± 10.2	107.2 ± 17.9
	change	1.8 ± 3.3	2.4 ± 4.1

<table>
<tr>
<td>5. Gui bin Song (2015)</td>
<td>40 subjects</td>
<td>1. Berg Balance Scale</td>
<td>
<table>
<tr><td></td><td>DTG</td><td></td><td>STG</td><td></td></tr>
<tr><td></td><td>Before</td><td>Post</td><td>Before</td><td>Post</td></tr>
<tr><td>BBS (scale)</td><td>37.5 ± 10.5</td><td>45.5 ± 6.3</td><td>42.3 ±7.7</td><td>45.9 ± 7.2</td></tr>
</table>
</td>
<td>According to the results of this study, dual-task training and single-task training were effective in improving balance in stroke patients, dual task training is more effective for increasing balance ability.</td>
</tr>
<tr>
<td>6. Ki Hun Cho (2015)</td>
<td>22 subjects</td>
<td>1. Gait Speed
2. Cadence
3. Stride Length
4. Step Length</td>
<td>
<table>
<tr><td></td><td></td><td>VRTCL group (n = 11)</td><td>VR group (n = 11)</td><td>X2 / t (P) values</td></tr>
<tr><td>Single task condition</td><td>Gait speed, cm/s</td><td>50.28 ± 14.58</td><td>49.37 ± 9.48</td><td>.173 (.864)+</td></tr>
<tr><td></td><td>Cadence, steps/min</td><td>68.58 ± 13.01</td><td>66.43 ± 13.27</td><td>.382 (.706)+</td></tr>
<tr><td></td><td>Step length, cm</td><td>31.70 ± 10.06</td><td>31.41 ± 7.21</td><td>.077 (.939)+</td></tr>
<tr><td></td><td>Stride length, cm</td><td>62.12 ± 18.81</td><td>61.10 ± 10.13</td><td>.158 (876)+</td></tr>
<tr><td>Dual task condition</td><td>Gait speed, cm/s</td><td>34.36 ± 13.48</td><td>31.27 ± 6.83</td><td>.677 (.506)+</td></tr>
<tr><td></td><td>Cadence, steps/min</td><td>55.35 ± 10.06</td><td>53.15 ± 7.77</td><td>.572 (.573)+</td></tr>
<tr><td></td><td>Step length, cm</td><td>26.51 ± 6.42</td><td>25.92 ± 3.61</td><td>.267 (.792)+</td></tr>
<tr><td></td><td>Stride length, cm</td><td>54.56 ± 12.68</td><td>53.69 ± 8.59</td><td>.166 (.870)+</td></tr>
</table>
</td>
<td>These findings demonstrated the efficacy of VRTCL on the walking function under the dual task condition. Therefore, we suggest that VRTCL may be an effective method for the achievement of independent walking in chronic stroke patients.</td>
</tr>
<tr>
<td>7. Jun Hwan Choi (2015)</td>
<td>20 subjects</td>
<td>1.K-MMSE
2. Verbal memory test</td>
<td>
<table>
<tr><td>Baseline</td><td>Dual-task group</td><td></td><td></td><td>Control group</td><td></td><td></td></tr>
<tr><td></td><td>Before</td><td>After</td><td>P value</td><td>Before</td><td>After</td><td>P value</td></tr>
<tr><td>K-MMSE</td><td>23.90± 4.91</td><td>26.80± 3.46</td><td>0.007</td><td>22.90± 5.82</td><td>25.50± 3.89</td><td>0.03</td></tr>
<tr><td>(Verbal memory test) DST-forward</td><td>4.00± 1.41</td><td>4.10± 0.99</td><td>0.79</td><td>4.50± 0.97</td><td>4.90± 1.66</td><td>0.23</td></tr>
<tr><td>DST-backward</td><td>3.00± 1.05</td><td>3.20± 0.79</td><td>0.53</td><td>2.90± 1.20</td><td>3.20± 0.79</td><td>0.32</td></tr>
</table>
</td>
<td>Our findings suggest that dual-task training could be as effective as conventional balance training for improving balance and cognition in subacute post-stroke patients.</td>
</tr>
<tr>
<td>8. Ho-Jung An (2014)</td>
<td>33 subjects</td>
<td>1. Functional Reach Test
2.10 Meter Walk Test
3.Time Up And Go Test</td>
<td>
<table>
<tr><td>Group Variable</td><td></td><td>MDGT</td><td>CDGT</td><td>MCDGT</td></tr>
<tr><td>FRT (cm)</td><td>Pre</td><td>22.56 ±7.86</td><td>22.36 ± 5.55</td><td>22.27 ± 6.13</td></tr>
<tr><td></td><td>Post</td><td>26.14 ± 8.06</td><td>23.82 ± 5.91</td><td>27.82 ± 6.32</td></tr>
<tr><td></td><td>change</td><td>3.57 ±0.50</td><td>1.45 ± 3.56</td><td>5.55 ± 1.13</td></tr>
<tr><td>10 MWT (m/s)</td><td>Pre</td><td>19.28 ± 9.50</td><td>19.33 ± 10.99</td><td>19.45 ± 7.92</td></tr>
<tr><td></td><td>Post</td><td>15.35 ± 6.68</td><td>17.31 ± 9.90</td><td>15.75 ± 7.73</td></tr>
<tr><td></td><td>change</td><td>−3.94 ± 3.53</td><td>−2.02 ±1.87</td><td>−3.69 ± 2.31</td></tr>
<tr><td>TUG (sec)</td><td>Pre</td><td>0.85 ± 0.38</td><td>0.93 ± 0.48</td><td>0.89 ± 0.38</td></tr>
<tr><td></td><td>Post</td><td>0.98 ± 0.49</td><td>0.96 ± 0.51</td><td>1.26 ± 0.54</td></tr>
<tr><td></td><td>change</td><td>0.13 ± 0.11</td><td>0.03 ± 0.04</td><td>0.38 ± 0.21</td></tr>
</table>
</td>
<td>The motor and cognitive dual task gait training was more effective at improving the balance and gait abilities of chronic stroke patients than either the motor dual task gait training or the cognitive dual task gait training alone.</td>
</tr>
<tr>
<td>9. GyeYeop Kim (2014)</td>
<td>20 subjects</td>
<td>1. Stroop Test
2.10 Meter Walk Test
3.Time Up And Go Test</td>
<td>
<table>
<tr><td></td><td></td><td>Before Intervention</td><td>After Intervention</td><td>Follow up</td></tr>
<tr><td>Stroop test</td><td>Single-task training group</td><td>32.50 ± 14.30</td><td>33.10 ± 13.07</td><td>34.20 ± 14.80</td></tr>
<tr><td></td><td>Dual-task training group</td><td>40.70 ± 15.68</td><td>51.00 ± 15.88</td><td>52.10 ± 16.62</td></tr>
<tr><td>Time up and go test</td><td>Single-task training group</td><td>42.41 ± 24.40</td><td>40.41 ± 22.88</td><td>40.60 ± 23.63</td></tr>
<tr><td></td><td>Dual-task training group</td><td>33.56 ± 20.71</td><td>24.19 ± 15.82</td><td>25.38 ± 16.13</td></tr>
<tr><td>10 meter walk test</td><td>Single-task training group</td><td>30.86 ± 14.85</td><td>27.46 ± 14.65</td><td>28.90 ± 14.58</td></tr>
<tr><td></td><td>Dual-task training group</td><td>26.20 ± 11.93</td><td>18.16 ± 12.17</td><td>19.44 ± 12.16</td></tr>
</table>
</td>
<td>Dual-task training improved cognitive and walking abilities, and dual-task training subjects' performance was better than single-task training subjects' performance. In addition, these training benefits were maintained for 2 weeks.
Dual-task training improves cognitive and walking abilities of patients with stroke.</td>
</tr>
<tr>
<td>10.Wonjae Choi (2014)</td>
<td>38 subjects</td>
<td>1.Berg Balance Scale
2.Functional Reach Test
3.Stroop Test</td>
<td>
<table>
<tr><td>Group</td><td></td><td>VUDT (n=12)</td><td>VDT (n=13)</td><td>UDT (n=13)</td></tr>
<tr><td>BBS</td><td>Pre</td><td>40.3 ± 7.5</td><td>41.2 ± 5.7</td><td>42.0 ± 4.4</td></tr>
<tr><td></td><td>Post</td><td>46.3 ± 7.4</td><td>45.1 ± 5.4</td><td>45.7 ± 4.8</td></tr>
<tr><td></td><td>change</td><td>5.9 ± 0.5</td><td>3.9 ± 0.5</td><td>3.7 ± 0.6</td></tr>
<tr><td>FRT</td><td>Pre</td><td>15.6 ± 7.8</td><td>18.8 ± 4.9</td><td>18.6 ± 5.4</td></tr>
<tr><td></td><td>Post</td><td>21.1 ± 7.4</td><td>22.5 ± 4.4</td><td>21.8 ± 5.3</td></tr>
<tr><td></td><td>change</td><td>5.5 ± 0.5</td><td>3.7 ± 0.5</td><td>3.2 ± 0.3</td></tr>
<tr><td>Stroop test</td><td>Pre</td><td>4.1 ± 1.6</td><td>3.9 ± 1.3</td><td>4.3 ± 1.2</td></tr>
</table>
</td>
<td>Dual task training applied with visual restriction and an unstable base in which the subjects attempted to maintain their balance was effective in</td>
</tr>
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<table>
<tr><td></td><td>Post</td><td>2.0 ± 1.0</td><td>2.9 ± 1.1</td><td>3.3 ± 1.1</td></tr>
<tr><td></td><td>change</td><td>−2.1 ± 0.3</td><td>−1.0 ± 0.2</td><td>−1.0 ± 0.2</td></tr>
</table>
</td>
<td>improving the balance and attention of stroke patients, and the VUDT was more effective than VDT or UDT.</td>
</tr>
<tr>
<td>11. Donghoon Kim (2013)</td>
<td>25 subjects</td>
<td>1.Gait Speed
2.Cadence
3.Stride Time
4. Stride Length</td>
<td>
<table>
<tr><td></td><td>Control (n=12)</td><td>Experimental (n=13)</td></tr>
<tr><td></td><td>Post-Pre</td><td>Post-Pre</td></tr>
<tr><td>Speed (cm/s)</td><td>-12.84 ±21.61</td><td>29.74 ±15.66</td></tr>
<tr><td>Cadence (step/min)</td><td>-3.16 ±10.07</td><td>14.98 ±9.42</td></tr>
<tr><td>Stride time (s)</td><td>-0.06 ±0.08</td><td>-0.16 ±0.10</td></tr>
<tr><td>Stride length (cm)</td><td>2.97 ±12.84</td><td>18.08 ±9.97</td></tr>
</table>
</td>
<td>The experimental group showed significant improvement in all selected gait measures except for temporal symmetry index under both task conditions. In the control group, there were no significant changes over the 4-week period for all selected measures. There was a significant difference between groups for all selected gait variables except for temporal symmetry index under both task conditions.</td>
</tr>
<tr>
<td>12. Yea-Ru Yang (2007)</td>
<td>37 subjects</td>
<td>1.10 Meter Walk Test</td>
<td>
<table>
<tr><td></td><td colspan="3">Dual-task group (n=19)</td><td colspan="3">Single-task group (n=18)</td></tr>
<tr><td></td><td>Pre-</td><td>Post-</td><td>Changes between pre and post-intervention</td><td>Pre-</td><td>Post-</td><td>Changes between pre and post-intervention</td></tr>
<tr><td>TUG (sec)</td><td>22.74 (15.20)</td><td>18.59 (13.97)</td><td>4.14 (2.16)</td><td>26.92 (8.87)</td><td>22.31 (6.12)</td><td>4.61 (7.77)</td></tr>
</table>
</td>
<td>The study results suggest that the performance of a cognitive-motor dual-task using auditory cues may influence balance improvements in chronic stroke patients.</td>
</tr>
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<td></td>
<td>361 subjects</td>
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</table>

DISCUSSION

This systematic review aimed to provide an overview of the dual task training approaches for balance and gait in Patients with Stroke of total 12 studies of dual task training was given in which 4 studies was compared with treatment approaches such as Tai Chi training, cognitive or motor tasks during walking, aquatic dual-task training and virtual dual-task treadmill training using a video recording.

The functional recovery of stroke patients is more effective when their therapies include high-intensity training and appropriate practices that allow voluntary use of specific motions and functions that are similar to actual tasks. Furthermore, adjusting the patient's pelvic movement is critical because dynamic balance is controlled by the harmonious movement between the pelvis and the upper body as well as by the muscles around the hip joint; the weights of the head, upper limbs, and trunk is transferred to the lower limbs through the pelvis. As a therapeutic method for restoration of this function, dual-task training is very popular, and active research is being conducted on the performance of dual tasks that reduce postural sway and improve postural stability.

Tai chi training on dual-tasking performance that involves stepping down was given to stroke survivors and showed significant improvement in dual-tasking performance was still found. This may support the value of Tai Chi training on dual-tasking performance in stroke survivors. The outcomes used were Auditory Stroop test, Stepping down test, Dual-tasking test involving both simultaneously. The main reasoning for the enhanced dual-tasking performance after Tai Chi training could be the increased attentional resources available to perform both the cognitive and physical tasks simultaneously. [6]

Cognitive and motor dual task gait training was given to improve dual task gait performance after stroke and showed significant improvement in DTC-speed and increase in stride length during cognitive-motor dual task walking after CDTT in stroke patients. No significant improvements in single walking or motor dual task walking performance after CDTT.

These results suggest training-specific improvements. MDTT was also found to have significant training-specific effects. Significant improvements in gait speed and stride length during motor dual task walking were found after MDTT. On the other hand, gait speed, cadence, and stride length were all found to improve during motor dual task walking after conventional physical therapy training. The outcome used were three test conditions to evaluate the training effects were Single walking, Walking while performing cognitive task (serial subtraction), Walking while performing motor task (tray-carrying). Parameters included Gait speed, Dual task cost of gait speed (dtc speed), Cadence, Stride time, and Stride length. The main reasoning may be the conventional physical therapy intervention, including muscle strengthening, balance, and gait training, might have improved motor capacity and reduced the attention needed to perform the motor task, permitting greater attention to be directed toward performing other concurrent tasks. The decrease in motor DTC-speed by 10.3% after CPT may also reflect partly the above mentioned speculation. Another reason may be different types of gait included in current study (cognitive dual task gait training, motor dual task gait training, and conventional physical therapy) may all positively impact single walking performance but through different effects on walking characteristics. [4]

Aquatic dual task training on balance and gait was given to stroke patients and showed that on intergroup comparison, the experimental group showed a relatively more significant change after the experiment in all balance and gait assessment tests. The outcome measures used were Berg balance scale, Five Times Sit-to Stand Test, and Functional Reach Test to measure Balance. 10-Meter Walk Test, Timed Up and Go Test, and Functional Gait Assessment to measure Gait. The main reasoning may be that Aquatic exercise uses the resistance and buoyancy of water to increase muscle strength and sensory feedback, leading to improved balance and gait ability. Therefore, aquatic dual-task training has a positive effect on balance and gait by activating sensory input in stroke patients. [1]

Virtual dual-task treadmill training using a real-world video recording of the gait was observed on individuals with chronic stroke and revealed significant improvement in the gait variables in both groups. The Outcome used were Temporospatial parameters of gait. A video recording was performed in a large supermarket, and the subjects could walk at their favorable speed on a treadmill. The main reason may Automatization of the control group which was improved due to the repetition of treadmill walking, whereas the proper allocation ability of coordination and attention was improved in the experimental group by virtual dual-task training, which led to the decreased CMI. CMI is a phenomenon that results in the deterioration in many aspects of gait ability, such as slower gait speeds, reduced cadence, and shorter stride length. Another reason may be Visual feedback in the virtual reality environment motivates the participants to actively participate in the training. Improvements in concentration as well as postural stability contribute to a normal gait pattern. Through this, the gait ability of stroke patients was improved. Similarly, virtual dual-task treadmill training using a video recording has strengths related to both dual-tasks and virtual reality. The intervention of virtual reality provided stroke survivors with motivation and emotional stability, and their Neuroplasticity increased through repetitive training of their damaged lower extremities, resulting in improved gait ability. Therefore, the control group probably showed more efficient improvements in gait ability. [7]

CONCLUSION

From the study it can be concluded that dual task training was found to be effective in improving functional performance when examine singly. When it was compare to other interventions such as tai chi training, cognitive or motor tasks during walking, aquatic dual task training and virtual dual task treadmill training dual task training was again found to be more effective. Therefore dual task training should be a part of conventional rehabilitation program for patients with stroke.

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