Original Article

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Effect of Visual Cue Training on Gait and Walking Velocity in Chronic Stroke Patients- A Quasi-experimental Study

Physiotherapy Section

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ABSTRACT

Introduction: Stroke is the major cause of disability and death in the world. More than 80% of stroke survivors face walking impairment due to muscle weakness, incoordination and spasticity. For physical rehabilitation of patients with neurological conditions combination of approaches are used. Visual cuing techniques are useful approaches for rehabilitation but the effect of visual cue training for gait and walking velocity is less explored for a patient with chronic stroke.

Aim: To determine the effect of visual cue training on gait and walking velocity in subjects with chronic stroke.

Materials and Methods: This was a quasi-experimental study in which 38 patients of chronic stroke were selected from various physiotherapy Outpatient Departments (OPD), of Surat, Gujarat from January 2019 to August 2020. Samples were randomly allocated into two groups, group A and group B; conventional and experimental group respectively. Group A was given conventional training and group B was given visual cue training along with conventional training for three days a week, 20 minutes/session. Both groups received conventional training five days a week, for four weeks. Dynamic Gait Index (DGI) and walking velocity were taken as an outcome measure and checked before intervention and after the end of four weeks of intervention. Statistical analysis was done using Statistical Package of the Social Sciences (SPSS) version 16.0. Paired t-test was carried out for within group comparison.

Results: The results of the study indicates that there was significant difference in DGI and walking speed preintervention and postintervention in both the groups ($p<0.001$). The mean difference of DGI in group A and B was 1.94±0.002 and 3. 26±0.41, respectively ($p<0.001$). The result of the study suggests that there is greater improvement in visual cue training group.

Conclusion: The present study results conclude that visual cue training along with conventional training shows greater improvements in gait and walking velocity than the conventional training alone.

Keywords: Attention allocation, Dynamic gait index, Vision, Visual feedback

INTRODUCTION

Stroke is an acute, neurological event that is caused by an alteration in blood flow to the brain. The traditional definition of stroke, given by World Health Organisation (WHO) in the 1970s is 'Neurological deficit of cerebrovascular cause that persists beyond 24 hours or is interrupted by death within 24 hours [1]. Stroke is one of the leading causes of death and disability in India. The prevalence rate of stroke ranges, 84-262/100,000 in rural and 334-424/100,000 in urban areas and the incidence rate is 119-145/100,000 based on the recent studies. There is also a wide variation in case fatality rates with the highest being 42% in Kolkata [2].

Disability and impairment have a considerable effect on patient's life, health and cost of social service. Despite of patients receiving standard rehabilitation there will be some degree of residual impairment and approximately 50% of patients are partially dependent in Activities of Daily Living (ADL) [3]. For rehabilitation of stroke patients, gait recovery is the major objective from all other problems to make patients less dependent in ADLs [4]. Only 30% of stroke patients can walk with the speed greater than 0.8 m/s after rehabilitation which is considered as the normal [5].

Various rehabilitation approaches like Bobath, motor relearning, neurodevelopment techniques are used as therapeutic treatment protocols to improve gait after stroke. This gait rehabilitation includes various methods such as neurodevelopmental approach, strength training, treadmill training, Despite of these multiple approaches gait impairments remain unchanged [6,7]. In stroke a single rehabilitation approach cannot significantly improve patient's condition. Cuing strategies are more useful rehabilitation approach along with other technique of rehabilitation as in the disorders like stroke [8]. Cues can be given by various cuing modalities such as auditory cuing, visual cuing, tactile cuing, and vibratory cuing from which auditory cuing has shown promising results in Parkinson's and stroke patients. From last decades visual cues are also aimed to improve gait and coordination as auditory cues in people with stroke [9,10].

The systemic review study of the Kristen Hollands in stroke patients shows that auditory cuing has promising improvement in the coordination of walking but still the effectiveness of other cuing modalities in improving gait and walking velocity in stroke patients are the unexplored concept [11]. There is vast amount of literature available on the effect of cuing technique on the gait of patients with neurological conditions specifically the effect of rhythmic auditory and visual cuing in patients with Parkinson's diseases and the concept is widely accepted and used in clinical practice.

There are very few studies on the effect of visual cue training in stroke patients, so objective of the study is to identify the effect of visual cue training to improve gait and walking velocity in chronic stroke patients [11,12].

MATERIALS AND METHODS

A quasi-experimental study was conducted for a duration of one and a half year from January 2019 to August 2020 after obtaining ethical approval from Institutional Ethical Committee (No: EC/SPB/020). Total 52 subjects were assessed for eligibility and 38 subjects were included from various physiotherapy OPDs of Surat, Gujarat India.

Sample size calculation: Sample size was calculated by pilot study using G power software (α=0.05 and power 80%, effect size=1.021, 10% drop out; sample size N=38).

Inclusion criteria: Subjects fulfilling the following criteria were included in the study:

- Age: 45-75 years;
- First episode of stroke;
- Duration of 6-18 months after first episode;
- Mental competency on Mini mental state examination ->24 [13];
- Fugl meyer Assessment (lower limb) -<34 [14];
- Tone on modified Ashworth scale -<3 [15].
- Berg Balance Scale -≥35 [16];
- Functional ambulation class: 3 or more than 3 [17];

Exclusion criteria: Subjects were excluded if they had any visual impairment, perceptual disorders, vestibular disorders, cognitive impairment, severe aphasia, gait deficit attributable to non stroke pathology and also subjects who were having gait speed more than 0.8 m/s [18].

Study Procedure

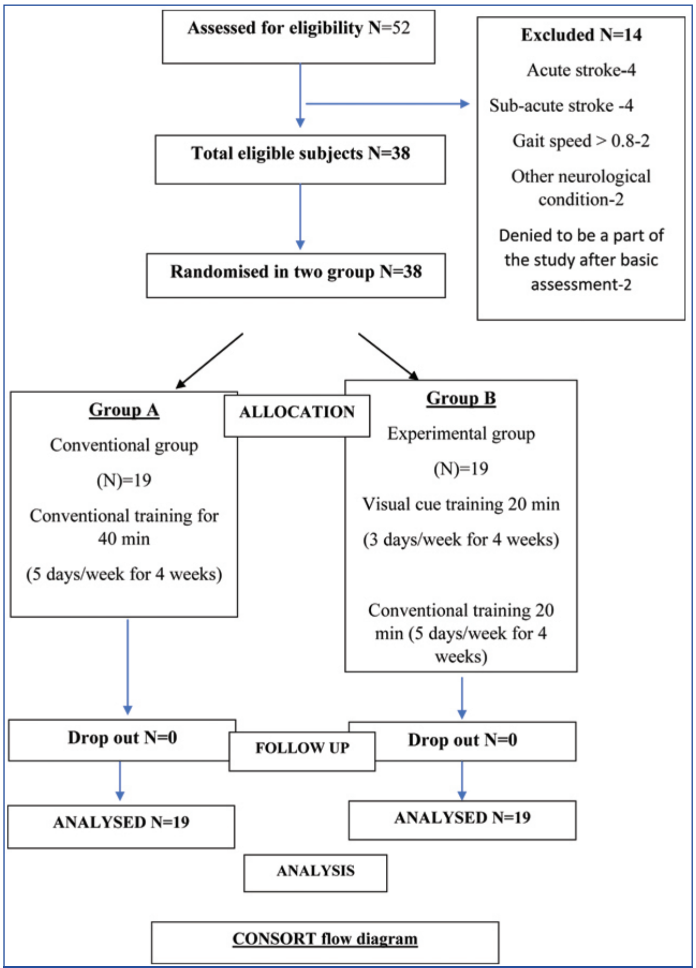
A written informed consent was obtained from subjects and they were allocated in two groups a conventional training group and visual cue training group using a lottery method. DGI and gait speed were measured using standardised procedure before starting intervention [19,20]. DGI is an observer type assessment tool which comprised of eight items and the total highest possible score is 24. Patient is made to perform the eight different tasks and then the score is recorded. To check gait speed the 10-meter walk test was performed on a 14 meter long pathway to account for acceleration and deceleration effect. The procedure was repeated twice and the average value of time for two test results was calculated and recorded in minutes [21]. A step length of subjects allocated to visual cue training group was measured by dipping foot of patients in boric powder and making them walk along a 10-meter walkway and at least six foot prints were taken to measure step length [22]. Average of hemiparetic limb and non hemiparetic limb step length was calculated and the summated distance of step length was used as the baseline step length for making visual cues. [Table/Fig-1] shows the flow diagram of the study procedure.

Intervention protocol: Following exercises were given to the patients as the part of conventional training [23]:

- Range of motion exercises of affected extremity;
- Passive stretching of tight muscles;
- Grip strengthening exercise;
- Strength training using free weights and elastic bandage for upper and lower limb major muscle groups.
- Conventional gait training:
  - Marching at place;
  - Walking forward, backward and sideways;
- Mat exercises- prone on hands, quadripod, kneeling and half kneeling

Number of repetitions and intensity of each exercise were increased based on patient's performance. The conventional training was given for four weeks, five sessions per week. One session of training last for around 40 minutes.

Visual cue training: For visual cue training visual cues were made on the floor using a white chalk. 2.5 cm wide and 90 cm long parallel lines were drawn on a 10-meter walkway. The inter line distance was kept 110% of the baseline step length [24]. The interline distance was gradually increased to 120%, 130%, 140% of baseline step length in 2nd 3rd and 4th week, respectively. Visual cue training was given for four weeks three sessions per week for 20 minutes per session. The protocol for conventional training was same as the conventional training group. After completion of four weeks the DGI and walking speed were measured.



[Table/Fig-1]: CONSORT flow diagram.

Example: If average paretic step length is 23 cm and non paretic step length is 17 cm. The average summated step length of the patient will be 20 cm. For patients with baseline step length of 20 cm the distance between two parallel lines for visual cue training in consecutive week will be as follows [Table/Fig-2-4].

[Table/Fig-2]: Measurement of step length.

Week 1: Distance between two lines is 110% of summated step length i.e., 22 cm

Week 2: Distance between two lines is 120% of summated step length i.e., 24 cm

Week 3: Distance between two lines is 130% of summated step length i.e., 26 cm

[Table/Fig-3]: Visual cues on the floor.

[Table/Fig-4]: Gait training using visual cues.

Week 4: Distance between two lines is 140% of summated step length i.e., 28 cm

STATISTICAL ANALYSIS

Statistical analysis was done using SPSS version 16.0. To analyse difference between pretraining and posttraining paired t-test was used and for the between group comparison independent t-test was used. The level of significance for all statistical data was set at α=0.005. Independent t-test was used to analyse difference between two groups.

RESULTS

The result of the study shows significant improvement in visual cue training group. The group A receiving conventional training consisted of 14 males and five females with the mean age of 55.21±8.175 years and group B receiving visual cue training consisted of nine males and 10 females with mean age of 60.52±9.50 years. The p-value evaluation of the outcomes at the baseline was 0.552 and 0.515 for DGI and 10-metre walk test indicates that both the groups were homogenous at the baseline [Table/Fig-5].

The result of paired t-test for intragroup comparison shows significant improvement in both the groups [Table/Fig-6].

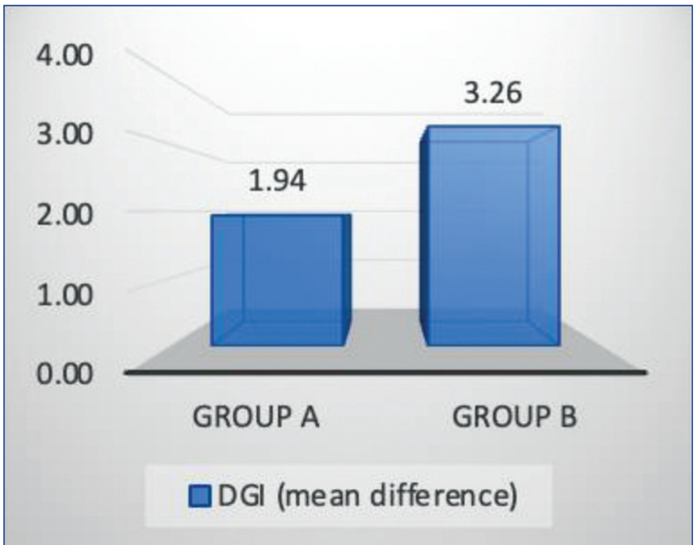
The result of intergroup comparison shows significant improvement in DGI and 10 MWT in visual cue training group [Table/Fig-7,8].

Variable	Group A (Mean±SD)	Group B (Mean±SD)	Mean difference	p-value
DGI (pre)	15.42±2.54	15.94±2.85	0.526	0.552
10 MWT (pre) (in minutes)	0.356±0.068	0.372±0.083	0.016	0.515

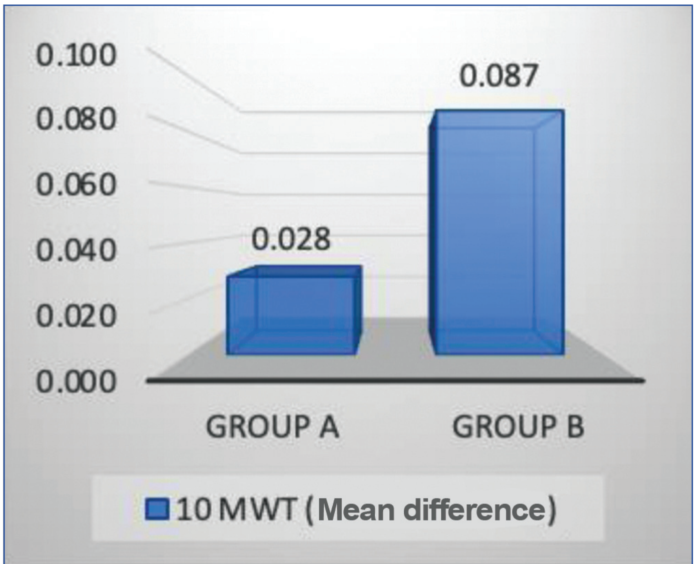
[Table/Fig-5]: Baseline evaluation of outcomes, MWT- Meter Walk Test.
*independent t-test for baseline evaluation of outcomes

Variable	Group	Pre	Post	Mean difference±SD	p-value
DGI	A	15.42±2.54	17.36±2.54	1.94±0.002	<0.0001
	B	15.94±2.85	19.21±2.43	3.26±0.41	<0.0001
10 MWT (in minutes)	A	0.35±0.068	0.38±0.070	0.0279 ±0.001	<0.0001
	B	0.37±0.083	0.46±0.081	0.0879±0.002	<0.0001

[Table/Fig-6]: Intragroup comparison of outcome measures.
*paired t-test (p<0.001**statistically highly significant)



[Table/Fig-7]: Intergroup comparison of DGI using independent t-test.
(p<0.001**statistically highly significant)



[Table/Fig-8]: Intergroup comparison of 10 MWT using independent t-test.
(p<0.001**statistically highly significant)

DISCUSSION

The result of the study suggested that visual cue training along with conventional training showed promising result on gait and walking velocity in subjects with chronic stroke. There is significant difference (p<0.001) in DGI and 10 MWT between group A and group B. The mean DGI change in visual cue training group was 3.26 which is higher than which is higher than the minimal detectable change of

S. No.	Author's name and year	Place of study	Number of subjects	Intervention done	Parameters compared	Conclusion
1.	Deepa S et al., (2019) [40]	India	30 Parkinson's disease patients.	Auditory cuing, visual cuing, combined auditory and visual cues.	Kinematic gait variables.	External visual cuing significantly improved gait and attention in motor task.
2.	Sunny S et al., (2017) [41]	India	40 elderly patients.	Balance training and visual cue training.	Balance and gait.	Visual cue training can be utilized for improving balance and reduce number falls in elderly.
3.	Khangare S and Deshpande M, (2016) [42]	India	30 Parkinson's disease patients.	Conventional training vs sensory enhanced therapy.	UPDRS scale.	Improvement in gait.
4.	Sarswat R et al., (2016) [43]	India	30 Parkinson's disease patients.	Visual cues vs treadmill training.	Balance and gait.	Gait training on treadmill shows more improvement in gait.
5.	De Icco R et al., (2016) [27]	Italy	46 Parkinson's disease patients.	Acoustic, visual cue training and over ground training.	Gait performance.	Gait training with cues is more effective compared to normal over ground training.
6.	Schlick C (2016) [44]	Germany	23 Parkinson's disease patients.	Visual cues combined with treadmill training.	Gait performance.	Visual cues combined with treadmill training has more positive effects.
7.	Sayed Het al., (2013) [45]	Egypt	28 Parkinson's disease patients.	Visual cue vs conventional training.	Spatiotemporal gait parameters and lower limb range of motion.	Significant improvement in visual cue training group.
8.	Hollands KL et al., (2015) [11]	United Kingdom	60 acute stroke patients clinical trial.	Over ground visual cue training, treadmill visual cue, usual care.	Gait, balance.	Improvement in mobility and reduce dependance in visual cue proctocols.
9.	Chouhan S et al., (2012) [12]	India	45 acute hemiparetic stroke patients.	Auditory cuing and conventional training, visual cuing and conventional training, only conventional.	Gait and upper extremity function.	Cuing training is effective than single conventional training protocol.
10.	Present study	India	38 chronic stroke patients.	Visual cuing and conventional training.	Gait and walking velocity.	Cuing training is effective in improving gait and walking.

[Table/Fig-9]: Comparison between similar studies [11,12,25,38-43].
UPDRS: Unified Parkinson's disease rating scale

DGI [25]. The possible mechanism of improvement in conventional training group could be the promoted learning and reorganising the work by non damaged brain areas due to involvement of structured repetitive exercises in every day [26].

Studies on the effect visual cue training on different neurological conditions were published previously supports the findings of the present study [12,27]. Robert De icco et al., conducted a study in 2016 with 46 Parkinson's disease patient which suggests that gait training with cues is more effective than normal gait training [27]. Another study of Chouhan S et al., was conducted in 2012 on 45 acute stroke patients also suggests that cuing training is effective compared to conventional training alone [12].

The possible neuro physiological mechanism behind the improvement in visual training group could be the allocation of attention during walking as it plays major role in gait control [28]. Stepping on the line of certain length distance improves attention along with induction in the dynamic visual flow for maintenance of locomotor pattern [29,30]. As attention is improved it changes to corticalised task [31,32]. The visual information converted into action is called visual motor process. The sensory information received during visually guided movement reaches to dentate nucleus of cerebellum for generation of movement [33]. This attention to visual information activates the cerebellum and basal ganglia which has reciprocal connection with brain stem and cerebral cortex for control of automatic motor process [34].

Another mechanism responsible for the significant positive change in gait and velocity could be the visual feedback as it enhances the motor function [35]. Due to linkage between the oculomotor and locomotor pathway there is a change in muscle co-ordination pattern which leads to controlled gait movement [5,36,37]. Postural sway of paretic leg decreases and the ankle movement increases to improve body control. In addition, visual movements improves accuracy and precision of foot placement [38,39]. Comparison between similar studies have been done in [Table/Fig-9] [11,12,27,40-45].

Clinical implication: The study serves as a basis for the use of visual cue training as an additional treatment approach to improve locomotor function of chronic stroke patients in clinical setting. Moreover this technique requires a minimum investment because it needs devices with basic technology which are readily available in market at low cost.

Limitation(s)

In addition to favourable results in gait outcome, this study has some limitations. There was a lack of follow-up after one month to determine the long-term effects of training for the participants. Hence, similar studies are suggested for the detection of long-term effect. The sample size used in this study was small, which implies that caution should be exercised when interpreting or generalising the results to entire stroke population. Due to lack of the literature on the effect of the visual cue training in stroke patients, there should be further studies advocated with larger sample size to collect more accurate results.

CONCLUSION(S)

In the present study, one month of training imparted to both the groups was effective in improving gait and walking velocity in chronic stroke patients after four weeks of intervention, however visual cue training was more effective than the conventional training alone. Furthermore this study provides evidence towards the cost-effective method of using external visual cue which can be used as an additional neurorehabilitative treatment in clinical settings without advance equipments.

A study with variable outcome such as gait of the stroke patient can be assessed with the use of a gait lab or other electromechanical devices to know precise change in the gait kinematics during walking after the intervention. Further study on the transverse line visual cues can be conducted to know the effect of visual cue training on the step length symmetry of paretic patients as an outcome because asymmetric step length leads to increase number of falls. Despite the increasing evidence that visual cue training may become a useful strategy in stroke rehabilitation, future research is required to determine optimal frequency, intensity and duration before its translation into standard clinical practice. Further study including the different stroke population such as sub-acute stroke patients can be administered for the results and clinical implementation.

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