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The Effect Visual Cue on Gait and Walking in Parkinsons Patients: A Review of Literature

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ABSTRACT

INTRODUCTION: Parkinson's disease is a neurological disorder that results in involuntary or uncontrolled movements, such as tremors, rigidity, impaired balance and coordination. The manifestation of symptoms related to Parkinson's disease is attributed to the depletion of several neurotransmitters, with dopamine being the most significant one. It often leads to a stooped posture that shifts the centre of gravity away from the centre of mass which results in a pathological gait where the upper body propels forward movement while the feet have to move rapidly to keep up. These swift, abbreviated steps are commonly referred to as festinating gait. Recent advances for the treatment of Parkinson's disease involves a range of approaches, such as exergaming and virtual reality, motor imagery, action observation, robot-assisted physiotherapy, external cues, LSVT (Lee Silverman Voice Treatment) and unconventional methods.

METHODOLOGY: Articles published between 2010 to 2023 were included and searched from Google Scholar, Science Direct, MEDline and PubMed. The articles were studied for the effects of external cueing (i.e visual, auditory and proprioceptive) on gait parameters and walking in patients with Parkinson's disease on stage II to IV on Hoehn and Yahr scale.

RESULT: 163 articles were obtained using keywords out of which 10 articles were selected according to inclusion and exclusion criteria. The study findings reveal the impact of external cues on gait parameters and walking in patients with Parkinson's disease.

CONCLUSION: The study concluded that a combination of external cues was more beneficial to patients with Parkinson's disease than un-cued gait training.

KEYWORDS: Parkinson's disease, gait, walking, Hoehn and Yahr II-IV, external cues, visual cues, auditory cues, proprioceptive cues.

INTRODUCTION

Parkinson's disease is a chronic, progressive neurodegenerative condition that primarily affects elderly people, however it can also affect patients who are considerably younger. It is the second most typical neuro-degenerative condition with evolvable layers.[1] It has been recognised by the loss of dopaminergic neurons in the Substantia nigra and the characteristic motor symptoms of parkinsonism associated with Lewy bodies.[2]

The presence of Lewy bodies which are defined as intracellular cytoplasmic aggregates made of proteins, lipids and other components is the other key histological characteristic of Parkinson's disease.[3,4] Lewy bodies are round bodies with radiating fibrils that are seen in dopaminergic neurons in the substantia nigra.[5,6] Their development may be a result of refractory proteolytic processes involving aberrant breakdown or overproduction affected by genetic abnormalities.[3,5,6] Alpha-synuclein (Syn) protein which is involved in gene mutations gets collected and forms insoluble fibrils related to Lewy bodies and these proteins have been identified as possible targets for Parkinson's disease treatment.[7]

Tremor, stiffness and bradykinesia are considered the three cardinal symptoms of Parkinson's disease. One percent of adults over the age of 65 years have Parkinson's disease, which has an increasing incidence and prevalence with age.[8] Parkinson's disease patients experience movement problems.[9] These signs result in various gait abnormalities.[10] People with Parkinson's disease take fewer steps, have shorter strides which results in higher cadences and have longer stance phases.[11] Freezing of Gait (FoG), which usually occurs during the beginning or deviation, is the main risk factor for falls. Stooped posture, freezing of gait (FOG), festination, shuffling steps and falling are common gait problems that are associated with Parkinson's disease.[12]

A dynamic interplay between regenerative and degenerative systems can be induced by exercise and training.[13] Dopaminergic and glutamatergic neurotransmission can be influenced by activity-dependent processes, which can then be used to control cortically induced hyperexcitability.[14] Exercise may strengthen synapses and enhance functional circuits, that would improve Parkinson's disease patients behaviour. Therefore, it is likely that the neurological component of Parkinson's disease rehabilitation is exercise-induced brain plasticity, which is the capacity of the central nervous system cells to alter their function and structure in reaction to a variety of external stimuli.[15] The main focus of physical therapy is on activity limitation associated with mobility, which includes physical capacity, transfers, manual tasks, balance and gait. The other main areas also include posture, which is a significant objective for physiotherapy treatment.[16]

There are three main components of physiotherapy treatment for gait problems in patients with Parkinson's disease. The first step is referred to as "strategy training". There are two types of strategy training (1) compensatory methods that work around damaged basal ganglia and (2) learning strategies that help you get better at something by doing it again. The second component is the management of secondary sequelae that emerge from deconditioning, decreased physical activity, advanced age and concomitant disorders and influence the musculoskeletal and cardiorespiratory systems. The third component is the encouragement of physical activities that help the individual develop new, lifetime fitness and physical activity habits and prevent falls.[17]

Recent advances include exergaming and virtual reality, motor imaging, action observation, robot-assisted physiotherapy and unconventional therapies. Recent developments in neuroscience have raised the possibility that exercise-based behavioural therapy for Parkinson's disease patients may enhance function and possibly hold back the progression of motor symptoms. The programs for people with Parkinson's disease have a special emphasis on the speech motor system (LSVT LOUD), but more recently they have also addressed limb motor systems (LSVT BIG). In order to help patients understand that movements with increased amplitude are within normal limits, even if they feel "too loud" or "too big." The LSVT Programs combine (a) an exclusive target on larger amplitude (loudness in the speech motor system; bigger movements in the limb motor system) with (b) a focus on sensory rebalancing and (c) training self-cueing and attention to facilitate long-term maintenance of treatment out.[18] The use of "cueing" and attentional movement techniques has been applied to such conventional methods. Providing external temporal or spatial stimuli (or "cues") might help in the initiation and maintenance of ongoing motor actions, especially rhythmic ones like gait. Cueing is seen as a specific intervention to compensate for the poor generation of internal signals in Parkinson disease.[19]

Cues are an essential part of rehabilitation and can help persons with neurological diseases like Stroke, Parkinson's disease, Alzheimer's disease, Traumatic brain injury and Multiple Sclerosis to execute tasks and engage in activities more successfully.[20] In order to improve motor learning, cues will be identified by an external system that increases sensory and perceptual feelings. These devices have demonstrated a decrease in cadence, a considerable improvement in balance, danger of falls, freezing, speed and stride length.[21]

Cues have been utilised in recent research in addition to conventional therapy for the improvement of gait and balance in Parkinson's disease patients, such as auditory, visual, tactile (sensory/proprioceptive) or electromyography.[21] Recently, there has been a lot of focus on a particular therapy approach that involves the use of external cues. These cues have included auditory, visual, cutaneous and instructional inputs. It is thought that the basal ganglia and the supplementary motor region coordinate the execution of consecutive movement components during normal movement. It has been proposed that the improvement shown with the use of external cues is due to these cues' ability to avoid faulty movement pathways in the basal ganglia, which are disrupted in Parkinson's disease by the basal ganglia disease. We evaluated the effectiveness of cues on the gait of Parkinson's disease patients and how these cues could interfere with the quality of life, psychomotor performance and freezing and we analysed which types of external cues would be the best for gait abnormalities.[22]

MATERIALS AND METHODOLOGY

➢ Sources of data collection

The Google Scholar, PEDro scale, Science Direct, MEDline and PubMed were used for reviewing literature. The terms Parkinson's disease, gait parameters, walking and external cues were used in the search. The search was restricted to just articles written in the English language.

➢ Study selection criteria

1. Inclusion criteria

-From Level 1 (Randomised Control Trials) through Level 5 (case reports), every level of evidence was considered for the review.

-Articles published between 2010 to 2023.

-Subjects with Parkinson's disease on Stage II to IV on Hoehn and Yahr scale .

2. Exclusion criteria

Articles are excluded from the review if

-The full text of the article was not available.

-Patients had Parkinson's Disease of Stage I and V of the Hoehn and Yahr scale.

-Neurological diseases other than Parkinson's disease.

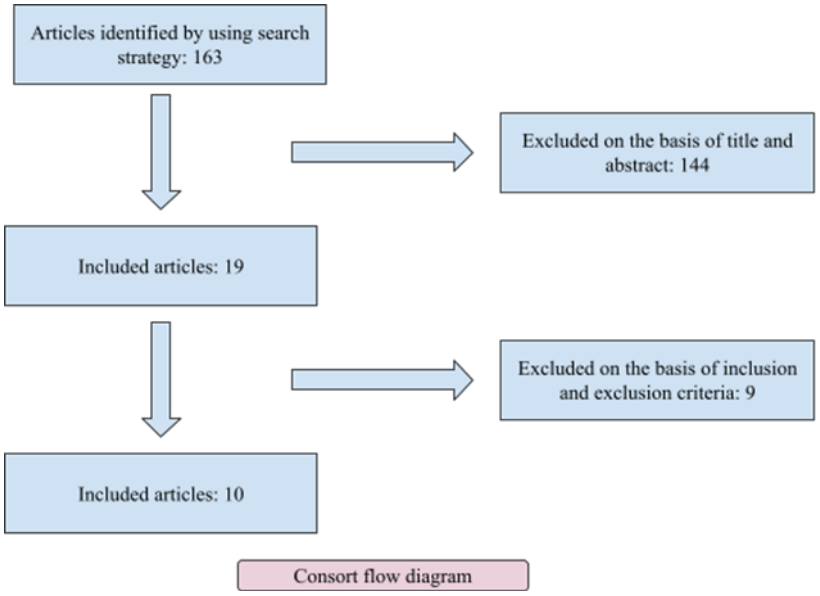
➢ Data extraction

Included articles were reviewed for the following information: level of evidence, research design, participant description, intervention description and outcome measure descriptions.

The following level of evidence was used for the review. (Table 1)[23]

Level 1	Systemic reviews, meta-analysis, Randomised control trials
Level 2	Non Randomised control trials, case control trials
Level 3	Pre-test-post test design, cross sectional studies
Level 4	Single subject designs, case series
Level 5	Case reports, narrative literature reviews

Figure 1



Summary of reviewed articles (Table 2)

Sr.No	Author	Study Design	No. of patients	Inclusion criteria	Intervention	Results	Level of evidence/ PEDro
1	Benjamin P. Dvorsky, **24**	Case Report	1	Hoehn and Yahr scale stage II to IV	Visual cues + Auditory cues + Lower limb and abdominal strengthening	Increase velocity, distance ambulated and decrease frequency of freezing episodes	Level 5
2	Zahra Kadivar **25**	Randomised control study	20	Hoehn and Yahr scale stage II to IV	Rhythmic Auditory Stimulation	Improvement in dynamic gait index and balance	Level 1 PEDro: 6
3	Rosemarie Velik **26**	Non Randomised control study	7	Hoehn and Yahr scale stage II to IV	Gait + visual cues + Auditory rhythm + Tactile rhythm	Decrease in duration of freezing	Level 2

4	Sook Joung **27**	Non Randomised control study	35	Hoehn and Yahr scale stage II to IV	Visual cues + Auditory cues + no cues	-Visual cues > Auditory cues enhaces gait in Parkinson's disease patients with freezing of gait. - Auditory cues > Visual cues enhances gait in patients with Parkinson's disease without freezing of gait and in healthy individuals	Level 2
5	F. Luessi **28**	Controlled volunteered study	19	Hoehn and Yahr scale stage II to IV	Dynamic pressure centres integrated in treadmill at velocities 1,2,3,4 km/hr + with or without visual cues	Improves stride length, stride time and decreases cadence, improves efficacy on treadmill	Level 2
6	Mohamed S El-Tamawy **29**	Double blinded Randomised control study	30	Hoehn and Yahr scale stage II to IV	Physio training + Treadmill training + Vibratory stimuli at plantar surface of feet + PNF	Improves parkinsonian gait kinematics, the hip, knee and ankle excursion	Level 1 PEDro:10
7	Hayan M Sayed **30**	Randomised control study	28	Hoehn and Yahr scale stage II to III	Visual cues + Physiotherapy treatment	Improvement in spatiotemporal gait parameters and increase in sit to stand movement	Level 1 PEDro:9
8	Roberto De Icco **31**	Randomised control study	46	Hoehn and Yahr scale stage II to IV	Auditory cues + Visual cues v/s Overground training without cues	**Acoustic group**: Acute- increase stride length ; Chronic -decrease number of strides and increase gait speed **Visual group**: Acute- decrease number of strides and gait speed; Chronic -decrease stride and increase in gait speed	Level 1 PEDro:9
9	Sarala Khangare **32**	Experimental study	30	Hoehn and Yahr scale stage II to IV	Visual cues +Auditory cues	**EG-** Improvement in step length, gait speed after 4 weeks of sensory enhanced therapy. **CG-** Training without sensory cues and no significant changes	Level 2
10	Cornelia Schlick **33**	Pilot Exploratory study, Non blinded Randomised control study	23	Hoehn and Yahr scale stage II to IV	Visual cues+Treadmill training v/s Treadmill training	Increased gait speed and stride length in group with combined treatment	Level 1 PEDro:6

***EG -** Experimental group, **CG -** Control group, **PNF -** Proprioceptive neuromuscular facilitation

RESULT

A total of 163 articles were identified using the specified keywords, title, abstract and study selection criteria. Out of these, 144 articles were excluded based on their title and abstract, while 19 articles did not meet the study selection criteria and were also excluded. Ultimately, a total of 10 articles were included in the review.

Figure 2

DISCUSSION

A review of several studies has revealed that the use of external cues can effectively enhance gait parameters and walking among individuals with Parkinson's disease. The articles provide evidence that various forms of external cues, including visual, auditory and proprioceptive cues are effective and valuable approaches for enhancing gait parameters in individuals with Parkinson's disease. According to the study's findings, combining external cues training with conventional training yielded encouraging outcomes in terms of gait and walking among patients with Parkinson's disease. Upon analysing the level of evidence, it was found that five articles suggest level 1 evidence.

According to the evidence, incorporating visual cues such as coloured stripes or tape on the floor in conjunction with conventional training can aid in improving step length, gait speed and stride length. This approach can also offer visual feedback that improves attention.[30,31] Similarly, integrating auditory cueing sounds such as clucks, dings, soft corks and beeps, can also improve gait speed, stride number and balance in individuals with Parkinson's disease.[25] Additionally, administering vibratory stimuli during treadmill walking as part of a conventional physiotherapy treatment program that incorporates proprioceptive neuromuscular facilitation technique can lead to improvements in stride length and walking speed.[29]

The positive outcome could be due to a pathophysiological visual feedback mechanism. The allocation of attention when walking, which is a key component of the walking process, may be the potential mechanism for the improvement seen in the visual training group.[34] Another cause for the significant improvement in gait and velocity could be visual feedback, which improves motor function.[23] The utilisation of visual cues, which serve as moving targets, activates the cerebellar-visual-motor pathway.[35] Consequently, the incorporation of visual cues can induce a shift in the control of gait, moving from the cortical-motor pathway to the cerebellar-visual-motor pathway.[35,36] However, study done by Ferrarin et al in 2008 suggested that mild Parkinson's disease subjects responds to the forward oriented optic flow which produces an increase in cadence and gait speed while subjects with severe Parkinson's disease tends to be more responsive to the attentional strategy, through an increase in step length and compensatory decrease in cadence.[37]

Also, visual and auditory cues can help as they focus attention on gait.[38] Once the patient is concentrating on walking, it is no longer an automatic task that is being processed through the basal ganglia thus bypassing it.[34] Basal ganglia acts as an internal cue or trigger to carry out smooth coordinated movements without attention.[36] In patients with Parkinson's disease, this internal cue is deficit, so the external cues incorporated in the treatment might have compensated for this internal motor trigger. Rhythmic sound patterns can increase the excitability of spinal motor neurons via the reticulospinal pathway reducing the time for the muscle to respond to the given motor command.[39] Auditory stimuli can reduce reaction time in a voluntary motor task which in turn can improve slowness of movement and gait.[40]

Some articles suggest that providing individual external cues can improve gait parameters, but the use of multiple external cues can result in more significant improvements. Therefore, using a combination of visual cues like marks or stripes on the floor and auditory cues like a digital metronome,

along with conventional training, can lead to enhancements in velocity, distance ambulated and a decrease in the frequency of freezing episodes.[24] According to Sarala Khangare, 2.5cm wide and 10cm long parallel lines on a 10 metre walkway, along with rhythmic counting of numbers and conventional gait training, results in notable improvements in step length and gait speed, as opposed to using only conventional gait training.[32]

CONCLUSION

Incorporating both visual and auditory cues along with conventional training for a period of 30-35 minutes yields better results when compared to only conventional training. To improve gait parameters and walking, it is recommended that the intervention program should last for at least four weeks, with three to five sessions per week. Additional randomised controlled trials with larger sample sizes and uniform methodology are needed to conclude more precise dosage of applying visual and auditory cues.

LIMITATIONS

- More articles with good quality PEDro scale needed.
- Heterogenous methodology was used in studies.
- Scarce information available.

FUTURE SCOPE

Future research should focus on further investigating the optimal dosage and delivery method for maximum efficiency.

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