

Effect of Different Types of Walking Aids on Gait and Balance in Patients with Stroke: A Review

Manisha Samal¹, Shivangi Mehra², Sakshi Saharawat², Dr. Chitra Kataria³

¹Student, MPO, ISIC Institute of Rehabilitation Sciences, New Delhi, India

²Assistant Professor, MPO, ISIC Institute of Rehabilitation Sciences, New Delhi, India

³HOD Rehabilitation Department & Principal, Indian Spinal Injuries Centre- Institute of Rehabilitation Sciences, New Delhi, India.

Corresponding Author: Manisha Samal

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ABSTRACT

Background: Stroke is a primary cause of fatalities as well as disabilities in the elderly, leading to an array of physiological impairments related to mobility and daily living tasks.¹ Among all the potential sensorimotor effects of a stroke, poor postural control has the biggest influence on gait and ADL independence. The mechanism underlying balance recovery after stroke has drawn more attention recently since developing successful rehabilitation strategies for stroke patients requires an understanding of these factors². Different types of walking aids are generally used to maintain walking capacity which is mostly compromised in stroke.¹ Therefore creating a need to investigate the effects of different types of walking aids on gait parameters and balance in patients with stroke to provide a better prescription criterion.

Objective: The objective of this literature review is to assess and evaluate the effect of different types of walking aids on gait and balance, which are most affected parameters in patients with stroke patients.

Study design: Literature Review

Significance: Unfortunately, many patients receive little or no professional consultation in selecting a walking aid, therefore this review was done to give a better perception about which kind of walking aid is best to improve gait parameters and balance among stroke patients.

Method: An electronic database search was conducted using google scholar, science direct, pub Med, Cochrane library and reference list from all the retrieved articles.

Results & Discussion: Professionals are often unsure which walking aid is best suited for post-stroke patients at the various stages of rehabilitation. Proper knowledge about the walking aids and proper assessment about the need of the patient is required to prescribe the best suited walking aid to the patient. Post-stroke patients are generally associated with an increased cardio-vascular loading during ambulation, that hampers their balance associated with reduction in walking velocity, cadence, step length etc. So, walking aids serves as the most appropriate option in improving gait and balance in order to improve their activities of daily living. Post-stroke patients walking with a cane showed significant improvement in their balance, stability and the temporo-spatial gait parameters. Use of cane showed more significant effect based on speed and step length in patients who are intermediate walkers as compared with independent ambulators.

Conclusion: The present literature review offers an idea for proper prescription of a walking aid for post-stroke patients. Canes are found as the widely used walking aids in comparison to walkers, crutches and sticks, especially the simple cane with ergonomic hand grip. Walking with a cane have positive impact on the various temporo-spatial gait parameters. Single point cane is found to be more beneficial for post-stroke patients with good balance who needs improvements in their gait parameters, whereas quad cane is more beneficial for patients with poor balance as it increases

stability. Various other canes (haptic cane, roller cane and instrumented cane) also have positive impact on the gait parameters of the patient.

Keywords: Walking aids, Gait parameters, Balance, Stroke.

INTRODUCTION

Stroke is the leading cause of disability globally, primarily due to limited mobility. Following a stroke, impaired walking capacity plays a major role in functional disability.⁴ The annual incidence of stroke is approximately 1.75% & two-third of the affected population is above 65years of age².

Since gait abilities are directly related to independent living problems as gait plays a significant role especially in disability after a stroke.³ Stroke leads to hemiplegia & patients develop a specific pattern of gait known as hemiplegic gait⁵ Hemiplegic gait is a term used by many clinicians to characterize a stroke patient's pattern of limb involvement and body posture while walking that leads to changes in several temporal and spatial parameters along with a noticeable decrease in velocity during a hemiplegic gait of patient^{4,6}. There is a reduction in cadence, step length, etc and increase in double support phase of gait because of impaired walking ability. Patients also experience an increase in oxygen consumption during gait which decrease their level of physical activity after stroke⁶. It is believed that the most significant predictor of ambulation ability for a stroke patient is their stability when standing and walking during hospitalization or discharge.⁷ By making up for the underlying impairments, walking aids are typically used to preserve a patient's stability and ability to walk and aim in assisting with balance and locomotion.^{6,8} Walking aids help to achieve independent

gait for patients with locomotor disorders. Crutches, walkers, quad canes, and standard single point canes are some of the varieties of walking aids which are mostly used.⁴ Walking aids serve the following main purposes: (1) better stability; (2) enhanced muscle action; (3) decreased load on weight-bearing structures;⁴ (4) support for hip and spinal extensor muscles; (5) aid in braking and accelerating during locomotion; and (6) lessen the shift of the centre of gravity during movement.⁷ Better knowledge about the various walking aids will help professional to do better decision making for selecting the proper walking aid for a patient based on their changing needs at every stage of their rehabilitative recovery to improve their gait and balance in order to have a quality of life.^{3,4,6}

MATERIALS & METHODS

Various articles from following database like google scholar, science direct, PubMed and Cochrane library were retrieved through a search by using key words-different types of walking aids, stroke, gait, temporo-spatial parameters, balance etc. Total 15 articles were included in the study and based on their findings, a review was made.

RESULT

Total 15 articles were taken and studied. Out of which one was cross-over trial, one qualitative study and thirteen were experimental studies. The details of the reviewed articles are tabulated in the given table 1.

Table 1: Details of the reviewed articles

Author	Title	Types of walking aid used:	Conclusion
Lee H et al. 2021	Comparative study on overground gait of stroke survivors with a conventional cane and a haptic cane.	Conventional cane & Newly designed Haptic cane.	Compared to an instrumented conventional cane, the usage of a haptic cane increased the user's walking pace and provided greater assistance. Patient may benefit from haptic canes with basic mechanisms that help deliver appropriate gait training modes and improve gait.

<i>Table no. 1 continued....</i>			
Deltombe T et al. 2020	Gait improvement in adult with hemiparesis using a rolling cane: A cross – over Trial.	Quadripod cane & Newly designed Rolling cane.	Use of cane or a crutch in patients with stroke help to improve gait symmetry and gait speed. Patients with upper extremity impairments who are neither able to utilize a walker nor are stable with a single point cane are more suited for quadripod cane recommendations. Using a Wheleo rolling cane improve the independence of quadripod cane users by increasing their walking speed, cadence, and distance traveled.
Regan J R et al. 2019	Effect of Provision of Cane on Walking Adaptability in Community Dwelling Post Stroke Patients	Single point cane with ergonomic hand-grip.	The use of cane showed significant changes on walking adaptability of immediate and fast walkers. Cane was more preferred by slow walkers as it decreased their time consumption for doing functional activities, but its increased the time taken in immediate and fast walkers.
Nascimento L R et al. 2018	Perception of individuals with stroke regarding the use of a cane for walking : a qualitative study.	With canes & Without canes	The use of cane had positive impact on walking ability for stroke patients with severe to moderate walking limitations. It improved their mobility, functional independence, safety and balance during walking.
Nascimento L R et al. 2015	The provision of a cane provides greater benefit to community-dwelling people after stroke with a baseline walking speed between 0.4 and 0.8 metres/sec: an experimental study.	Single point cane with ergonomic hand grip.	Based on walking ability, the use of cane proved to be more beneficial for intermediate walkers compared to slow and fast walkers. Both slow walkers with lower expectations of improving walking ability and community-dwelling stroke patients whose walking has stabilized with expectations of high walking speed and extended step length can use canes.
Jeong Y G et al. 2014	Which type of cane is most efficient, based on oxygen consumption and balance capacity in chronic stroke patients?	Standard cane, Quad cane, & Hemi-walker	The single point cane showed effect of increased oxygen expenditure, gait endurance and gait velocity with decreased oxygen cost compared to quad cane and hemi-walker for stroke patients with good balance.
Jung k , Kim Y et al. 2014	Effects of gait training with a cane and an augmented pressure sensor for enhancement of weight bearing over the affected lower limb in patients with stroke : a randomized controlled pilot study.	Single point cane with pressure sensors.	Conventional canes are effective in providing stability at early stage of rehabilitation . But for patients who want to improve their quality of gait and muscle activation in paretic limb, walking with canes having sensory feedback is best appropriate method of gait training.
Polese J C et al. 2011	The effect of walking sticks on gait kinematics and kinetics with chronic stroke survivors.	Walking sticks	The use of walking stick had positive impact on increasing power generation of the ankle plantar flexors, knee extensors & hip flexors of the paretic limb at both comfortable and fast speeds, that helped to improve the walking speed of the patient.
Parez C et al. 2011	An instrumented cane devised for gait rehabilitation and research.	Newly designed instrumented cane	The instrumented cane showed significant impact on improving gait in stroke patients, mainly the lower functional ambulators. Treadmill gait training with instrumented cane is more beneficial.
Boonsinsukh R et al. 2009	Light touch cue through a cane improves pelvic stability during walking in stroke.	Single point cane with light touch contact fashion & Force contact.	The use of cane with light touch contact provides lateral stability during walking for patients same as obtained when using cane in force contact method because of the augmented sensory information produced that activates the weight bearing muscles on the paretic limb during stance.
Allet L, Leemann B et al. 2009	Effect of different walking aids on walking capacity of patients with poststroke hemiparesis.	Simple cane, 4- point cane, & Nordic stick.	The study compared the simple cane with ergonomic handgrip with 4-point cane and Nordic stick based on temporo-spatial parameters and walking capacity. The simple cane was more preferred and had positive impact on patients at early stage of rehabilitation that help them to walk greater distance with high velocity & cadence.
Laufer Y et al. 2003	The effect of walking aids on balance and weight bearing patterns of patients with hemiparesis in various stance positions.	Standard cane & Quad cane.	Effect of walking aid on improving postural sway become greater when aid is held on the contralateral side. Quad cane is more advantageous in reducing postural sway and improving stability in stroke patients compared with standard cane by providing more medio-lateral base of support.
Laufer Y et al. 2002	Effects of one-point and four-point canes on balance and weight distribution in patients with hemiparesis.	Single point cane (one-point) & Quad cane (4-point)	Although not to the same extent as in healthy individuals, walking aids did help with stability in some way. With a four-point cane during the stance phase, patients' stability was enhanced and postural sway was significantly reduced when compared to one-point and no cane. Neither cane type affected the weight bearing on the paretic leg. The weight shift towards the walking aid do not have any effect on weight bearing distribution on the affected limb but weight bearing on the unaffected limb was reduced.
Chen C L et al.	Temporal stride and force analysis of cane- assisted gait in people with hemiplegic stroke.	Instrumented single point cane.	The cane provide limited support for the affected limb with less than 25% body weight. In order to enhance forward motion onto the sound limb, the cane also offers braking assistance.

2000			Those who walk with a cane after a stroke use their affected limb and cane for braking and propel themselves with the sound limb.
Kuan T S et al. 1999	Hemiplegic gait of stroke patients: The effect of using cane.	Standard cane & Quad- cane	The study made a comparison of various temporo-spatial variables (walking velocity, cadence, stride length and step length) and kinematic variables between patients walking with a cane and without a cane. Walking with a cane have a positive impact stride period, stride length, step length and single support period of affected limb but with decreased cadence and a little effect on walking velocity compared with no cane walking.

DISCUSSION

After regress literature review it is evident that in hemiplegic stroke patients, sustained gait deviation demand for higher level of oxygen consumption, that decreases their level of physical activity and balance capacity. Due to deficits in cardiopulmonary function, hemiplegic individuals also document for higher oxygen demand during activities of daily living (ADL), which results in increased cardiovascular loading. With this knowledge, it is clear that reducing oxygen consumption and cardiovascular exertion by improving their stability, balance capacity and ability while walking is crucial for stroke patients undergoing gait rehabilitation, which enhances their functional abilities and level of physical activity depending on their changing needs at every stage of their recovery^{1,6}.

Based on our current understanding, a review was conducted to determine the benefits of various types of walking aids for hemiplegic patient's direct oxygen consumption during walking, taking into consideration their balance capacity and gait parameters^{1,6}.

Different types of Walking Aids:

Walking aids are most commonly used by stroke patients to maintain their walking capacity and improve stability during gait by compensating for the underlying impairments. They also boost patient's sense of security and reduce fear of falling. There are varieties of potential walking aids that are generally used by stroke patients: walking frames with/without wheels, 3-point canes, 4-point canes, single point(standard) cane, crutches, straight canes(sticks), etc⁶. Out of all the varieties available, different types of canes are

widely prescribed as walking aids for stroke patients¹. Standard cane and quad cane are frequently recommended in order to achieve balance stability and walking ability among the patients.^{1,9}The use of cane in touch contact fashion helped to improve lateral stability and decreased postural sway of patient by the producing augmented sensory information that facilitated the muscle activation of the paretic leg for weight bearing during stance¹². The newly designed haptic cane compared to the designed instrumented cane also improved patient gait by paretic muscle activation⁵. Gait training with a cane associated with augmented pressure sensors also improved balance, muscle activity and gait¹⁰. Adults with hemiparesis using a quad cane are more benefited from the use of rolling cane as it makes them comfortable to walk longer distances with faster speed¹⁴. The instrumented cane also made improvements in gait for stroke patients with low functional ambulation category with stroke when walking on a treadmill¹⁵.

Gait and Balance:

Stroke patients are characterized in having a specific pattern of gait known as hemiplegic gait. Their gait is associated with significant decrease in walking speed and changes in temporal and spatial parameters of gait along with reduction in cadence, step length, single limb support period of involved limb and there is an increase in double limb support period^{5,6}. Standing balance and stability during walking is also compromised in post-stroke patients which is characterized by postural sway and medio-lateral instability during standing and walking respectively⁹.

The best indicator of walking ability is Speed and an increase in speed is found to

be related with the perception of higher quality of life, which can be significantly improved among stroke patients by the use of walking aids as it is clearly observed and demonstrated that walking aids improves balance and enhance stability resulting in a better gait mechanics³.

Researches depicts that simple cane with ergonomic hand grip have a significant impact on improving walking capacity, walking speed, stride length, stride period, affected side step length but with a decrease in cadence and step width.^{3,4,6} Many studies have shown that quad cane or the 4-point cane is more beneficial for patients who have poor balance and require more stability as most of the weight is transferred to the walking aid because of increased medio-lateral base of support.^{1,8,9} Whereas single point cane or the standard cane is more useful for patients with good balance as it improves their gait endurance and gait velocity.^{1,6}

Independent ambulatory stroke patients walking with cane produced non-significant increase of 0.05meter/sec in speed and 4cm in step length but for intermediate walkers, it produced significant increase of 0.18meter/sec in speed and 7cm in step length. For slow walkers, cane improved their stability and confidence whereas for fast walkers, cane reduced their speed and cadence because of increased dependency on walking aid.¹³

CONCLUSION

After extensive analysis of available literature, we found that there are many studies depicting that canes are most widely used walking aids as compared to walkers (with/without wheels), crutches and sticks as it provides maximal benefits to the stroke patients who are intermediate walkers. We found that single point cane is more effective in improving the gait endurance and velocity in patients with good balance, but it is associated with a increased oxygen consumption.¹ Where as quad cane is found to be more effective for post-stroke patients who have poor balance and rely on

walking aid for stability and base of support in order to get a balanced posture and gait.^{1,9}

Studies have also shown that all the newly designed canes i.e. haptic cane, instrumented cane, and rolling cane along with conventional canes with sensory feedback program have significant effect in improving the balance and gait of the hemiparetic stroke patients.^{5,12,14,15}

Therefore this review might be beneficial for the professionals who are prescribing different types of walking aids to the patients, in order to prescribe a best suited walking aid based on their need and assistance required during various stages of recovery so that it can serve to provide improvements in all the therapeutic procedures focusing on gait and balance which will enhance their walking ability, stability, balance and functional abilities thereby improving the community involvements of stroke patients.

Limitation:

- In the present study, the effectiveness of walkers and crutches is less specified as maximum studies focused on the use of canes and its effect on gait and balance.
- This study lacks information about the joint kinetics and kinematics of foot, ankle and knee complex which plays a major role in temporo-spatial characteristics of gait effecting stroke patients.
- This review lacks the evidence about the effectiveness of various types of walking aids based on the different stages of stroke (precisely chronic or acute) and extent of severity and posture deficits affecting gait and balance.

Future Aspects:

- New sophisticated designs of cane can be developed to minimize the energy expenditure of walking for post-stroke patients.
- More experimental studies can be done to evaluate the effect of cane on weight distribution and postural control during gait for patients with stroke.

- More study on evaluating the effect of walking aids on the joint kinetics and kinematics of stroke patients during walking can be conducted.

Declaration by Authors

Conflict of Interest: The authors declare no conflict of interest.

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