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Impact of Pelvic Alignment and Balance on Clinical and Community Walking Performance in Patients with Stroke: A Cross-sectional Study

Mishra Ashwini V[1], Harishchandre Maheshwari S[2] and Ganvir Suvarna[3]

[1]MPT in Neurophysiotherapy, DVVPF'S College of Physiotherapy, Ahmednagar, India

[2]Associate Professor, Neurophysiotherapy, DVVPF'S College of Physiotherapy, Ahmednagar, India

[3]HOD and Professor, Neurophysiotherapy, DVVPF'S College of Physiotherapy, Ahmednagar, India

ABSTRACT

Background: Stroke is global health problem leading to significant mortality and morbidity. Patients with stroke has asymmetrical weight bearing and altered pelvic alignment. Low cardiovascular fitness affects the ability of walking and promote negative effect on overall health. So, the purpose was to analyse the influence of pelvic alignment on balance, and gait in patients with Stroke and its relation with walking performance.

Methods: 39 patients with Sub-acute and Chronic Stroke were recruited in a Cross-sectional study. Participants were assessed by measuring the Pelvic Alignment by using Palpation Meter, Balance and Gait by Tinetti Performance Oriented Mobility Scale (POMA), Walking speed and Walking distance in Clinical and Community set-up by 10 m walk test and 6 Minute Walk Test (6MWT).

Result: Anterior Pelvic tilt (APT) shows negative correlation with POMA (r= -0.5, p= 0.0004) and Lateral Pelvic tilt (LPT) shows no negative corelation with POMA (r= -0.12, p= 0.34). APT was negatively correlated with Clinical (r= -0.63, p< 0.05) and community (r= -0.61, p< 0.05) walking speed along with the Clinical (r= -0.66, p< 0.05) and community (r= -0.66, p< 0.05) walking distance and LPT shows no significant negative corelation with clinical and community Walking speed and walking distance. Balance and gait component of POMA was positively corelated with walking performance. Walking speed and distance was extremely significant between two set up.

Conclusion: The study concluded that there is impact of Pelvic alignment and balance on clinical and community walking performance in patients with Stroke.

***Corresponding author**

Mishra Ashwini V, MPT in Neurophysiotherapy, DVVPF'S college of Physiotherapy, oppo Govt Milk dairy, MIDC, Vilad ghat, Ahmednagar, India. Tel: 8693087617.

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Introduction

Stroke is global health problem leading to significant mortality and morbidity; [1] 15% to 30% patients exhibit severe disabilities [1, 2].

Patients with stroke has asymmetrical weight bearing and altered pelvic alignment [3]. Low ambulatory activity and cardiovascular fitness affect the ability of walking and promote negative effect on overall health [4].

There was lack of evidence having all factors investigated together which is inclusive of pelvis, balance and gait for predicting walking ability.

Thus, the objectives were to analyse the influence of pelvic alignment on balance, and gait in patients with Stroke and its relation with walking performance.

Materials and Methods

In the present cross-sectional study, 39 patients with Sub-acute and Chronic Stroke were recruited through purposive sampling from Physiotherapy OPD and Stroke centre. Patients diagnosed with stroke, Mini- Mental Status Examination (MMSE) score: >24, Spasticity grade from 0 to 1+ according to Modified Ashworth Scale for Lower extremity, Brunnstrom recovery stage ≥ 3, Walking ability with or without aid were included.

Any diagnosed recent lower limb or pelvis fracture or recent surgery of lower limb, any previous mal alignment of Pelvis, neurological Conditions other than Stroke were excluded. Ethical Clearance was obtained from the Institutional Ethical Committee of Physiotherapy College and Informed consent was taken.

Procedure

Participants meeting the study criteria were included in the study and informed consent were taken. Participants were assessed by measuring the Pelvic Alignment by using Palpation Meter Instrument, Balance and Gait by Tinetti Performance Oriented Mobility Scale (POMA), Walking speed in Clinical and Community set-up by 10 m walk test and Walking distance in Clinical and Community set-up by using 6 Minute Walk Test (6MWT).

For assessing the Anterior- Posterior Pelvic alignment using Palpation Meter (PALM)- Patients were asked to stand as erect as possible. Anterior Superior Iliac Spine (ASIS) and Posterior Superior Iliac Spine (PSIS) was palpated and calliper tips were position over the marked bony landmarks. The patient was then asked to take a deep breath, exhale and wait to inhale again till the measurement was recorded.

For assessing the Lateral Pelvic alignment using Palpation Meter (PALM)- Superior aspect of the Iliac crest was palpated and marked, the PALM callipers were placed over the bony landmarks and patient was instructed to take a deep breath and then exhale, and wait to inhale again till the measurement was recorded.

Balance and Gait abilities was assessed using Performance Oriented Tinetti Assessment scale (POMA). Scoring of the items are on two- point scale (0 and 1) and three- point scale (0, 1 and 2) and total Possible score is 28.

Walking speed was assessed using 10 metre- walk test- 14-meter walkway was marked and participants were asked to walk at normal comfortable speed, time was measured for only ten meters excluding the first and last two meters. As the toe passes the two metres mark, the timer was started and when toe passes 12 metre mark the timer was stopped. The gait speed was examined by measuring the time required by the participants to complete ten meters. Two trials were performed and average of two trials was calculated. Same procedure was performed in community set-up. Two trails were taken and average was calculated.

$$\text{Formula- Walking Speed} = \frac{\text{Total Distance}}{\text{Time}}$$

Walking distance was assessed using 6 Minute walk test- A 60 m distance was marked in clinical set-up and the track was marked with tapes at 3 m Interval. participants were asked to walk for six min from the starting point toward another reference point; They were instructed that they could slow down and rest if necessary and then start again to walk. After six min, the total walking distance was recorded in meters, as well as the number of laps from the starting point to the reference point was calculated. Same procedure was performed in Community set-up. It was calculated by:

Total distance= no. of laps× 60 metres+ final partial lap

Result

Data analysis was done using GraphPad Instat 3. Descriptive statistics was used to analyse the Demographic variables of all the participants. Pearson correlation was used to correlate between the Pelvic Alignment and Balance and Gait component of POMA and Clinical and Community walking performance. Paired t-test was used to compare difference between clinical and community walking speed and walking distance. Level of significant was set as $p<0.05$.

Table No. 1 summarizes the Demographic variables of 39 Stroke subjects with mean age 53.8 ± 11.9 years and duration. Brunnstrom's Stage of Recovery for the lower limb were distributed from Grade 3 to Grade 6.

Table 1: Demographic data in Patients with Stroke

	Variables	n	Percent (%)
Duration of Stroke	Subacute	14	35.9 %
	Chronic	25	64.1 %
Gender	Males	32	82.1 %
	Females	7	17.9 %
Side Affected	Left	21	53.8 %
	Right	18	46.2 %
Type of Stroke	Haemorrhagic	3	7.7 %
	Ischemic	36	92.3 %
Brunnstrom Recovery Stage	Stage 3	13	33.3 %
	Stage 4	18	46.2 %
	Stage 5	8	20.5 %
	Stage 6	-	-

Table No. 2 Summarizes the Mean and SD of all the outcome variables used for the Assessment.

Table 2: Mean of Outcome Variables

Sr. No.	Outcome Variables	Sub components	Mean ± SD
1.	Pelvic Alignment	Anterior Pelvic Tilt (in cm) (n=37)	2.2±0.7
		Posterior Pelvic Tilt (in cm) (n=2)	1.9 ±0.57
		Lateral Pelvic tilt (in cm) (n=39)	1.6±0.7
2.	Tinetti Performance Oriented Mobility Assessment (POMA)	Balance component	11.2±3.9
		Gait components	8.6±3.4
		Total	19.8±7.0
3.	Walking Performance	Clinical Walking speed (m/s)	0.6 ±0.3
		Community walking speed (m/s)	0.4±0.2
		Clinical Walking distance (m)	184.1±109.9
		Community walking distance (m)	137.6±111.2

Table No. 3 Summarizes the relation between Pelvic Alignment and POMA. APT shows negative correlation with POMA and LPT shows no negative corelation with POMA.

Table 3: Correlation Between Pelvic Alignment and Tinetti Performance Oriented Mobility Assessment (POMA)

Outcome	Mean ± SD	Outcome	Mean ± SD	r value	p value	Result
Anterior Pelvic tilt (n=37)	2.2±0.7	Balance component	11.2±3.9	-0.51	0.001	Very Significant
		Gait component	8.6±3.4	-0.56	0.0003	Extremely Significant
		POMA	19.8±7.0	-0.5	0.0004	Extremely Significant
Lateral pelvic tilt (n= 39)	1.6±0.7	Balance component	11.2±3.9	-0.15	0.33	Not Significant
		Gait component	8.6±3.4	-0.14	0.38	Not Significant
		POMA	19.8±7.0	-0.12	0.34	Not Significant

(*POMA= Performance Oriented Mobility Assessment)

Table No. 4 summarizes the correlation between the Pelvic alignment with clinical and community walking performance. APT was negatively correlated with Clinical and community walking performance and LPT shows no significant quite negative corelation.

Table 4: Correlation Between Pelvic Alignment and Clinical and Community Walking Performance

Outcome	Mean± SD	Outcome	Mean± SD	r value	p value	Result
Anterior Pelvic Tilt (APT) (n=37)	2.2± 0.7	Clinical walking speed	0.6 ±0.3	-0.63	<0.0001	Extremely Significant
		Community walking speed	0.4±0.2	-0.61	<0.0001	Extremely Significant
		Clinical walking distance	184.1±109.9	-0.66	<0.0001	Extremely Significant
		Community walking distance	137.6±111.2	-0.66	<0.0001	Extremely Significant
Lateral Pelvic Tilt (LPT) (n=39)	1.6±0.7	Clinical walking speed	0.6 ±0.3	-0.31	0.06	Not Quite significant
		Community walking speed	0.4±0.2	-0.26	0.10	Not Significant
		Clinical walking distance	184.1±109.9	-0.29	0.07	Not Quite significant
		Community walking distance	137.6±111.2	-0.29	0.08	Not Quite significant

Table No. 5 summarize the correlation between POMA and Clinical and Community Walking performance. POMA shows significant positive corelation with Clinical and community walking performance.

Table 5: Correlation Between Balance and Gait Component of POMA With Clinical and Community Walking Performance

Outcome	Mean± SD	Outcome	Mean± SD	r value	p value	Result
Balance Component of Poma	11.2±3.9	Clinical walking speed	0.6 ±0.3	0.45	0.003	Very Significant
		Community walking speed	0.4±0.2	0.48	0.002	Very Significant
		Clinical walking distance	184.1±109.9	0.72	<0.0001	Extremely Significant
		Community walking distance	137.6±111.2	0.66	<0.0001	Extremely Significant
Gait Component of Poma	8.6±3.4	Clinical walking speed	0.6 ±0.3	0.48	0.001	Very Significant
		Community walking speed	0.4±0.2	0.51	0.0007	Very Significant
		Clinical walking distance	184.1±109.9	0.69	<0.0001	Extremely Significant
		Community walking distance	137.6±111.2	0.66	<0.0001	Extremely Significant

(*POMA= Performance Oriented Mobility Assessment)

Table No. 6 summarizes the comparison of walking performance in Clinical and Community setup. Walking speed and walking distance shows extremely significant results between two set up

Table 6: Comparison of Clinical and Community Walking Performance

Walking Performance	Set-up	Walking Speed (m/s)	t- value	p value	Result
10 M Walk Test	Clinical Set-up	0.6 ± 0.3	6.3	0.0001	Extremely Significant
	Community set-up	0.4± 0.2			
		Walking Distance (m)			
6 MWT	Clinical Set-up	184.1 ± 109.9	9.12	0.0001	Extremely Significant
	community set-up	137.6 ± 111.2			

(*6MWT= Six Minute Walk Test)

Discussion

The present study was carried out to see the Impact of Pelvic Alignment and Balance on Clinical and community Walking performance in patients with Stroke.

The study demonstrated that there is Impact of Pelvic alignment on clinical and community walking performance and the Impact of Balance and Gait component of POMA on clinical and community walking in Patients with Stroke.

The result indicates that greater the pelvic mal-alignment, greater the increase in gait time and lesser the distance covered by the patients both clinically and on community level. In addition, there was significant correlation between the pelvis and the balance and gait component. More the mal-alignment of pelvis, there is greater decrease in balance and gait ability.

In the present study the Pelvic alignment i.e., the Anterior pelvic tilt is significantly correlated with Balance and Gait component of POMA.

It is believed that after Stroke, there is poor abdominal activity of the most and least affected side. The muscles of abdominal wall are attached to Linea alba through the central aponeurosis and excessive trunk extensor activity contribute to forward tilting of ASIS towards the femur leading to anterior tilt [5].

Myoung-Kwon Kim et al (2018) stated that anterior tilt is associated with balance dysfunction and weight-bearing asymmetry and abnormal tilt is related to trunk control and balance which is important for gait function and have effect on velocity, step and stride length [6].

Author Geert et al. suggested that following Stroke, forward leaning posture with anteriorly tilted pelvis is common and this atypical postural alignment was correlated to trunk and balance dysfunction. This suggest that pelvic stability in forward and backward direction is well co-ordinated by trunk- pelvis and pelvis-hip dissociation and thus the lack of active muscle stabilization might lead to poor control of lumbopelvic position [7].

A study done by Yu-Won Choe (2021) on the Chronic Stroke patients contradict the finding they reported that anterior pelvic inclination could not affect the gait and balance function. The lateral pelvic alignment than the anterior pelvic alignment affects the weight bearing symmetry leading to altered gait and balance. The possible explanation was that the patients participated had various postural abnormalities (kyphosis, lordosis) which might have altered the findings[8].

In the current study, the Lateral pelvic tilt was not significantly correlated with the Balance and Gait components of POMA Scale.

In standing, normal side to side pelvic alignment is controlled by the activity of hip abductors along with trunk control [9]. Hip abductors act as pelvic stabilizer and altered recruitment of hip abductor influences the pelvic stability leading to lateral pelvic tilt [5].

In current study, patients had fair (43.6%) to good (20.5%) strength of Hip Abductor muscles which may have led to non-significant result.

Study done by Tyson et al showed poor trunk control and pelvic instability might allow for excessive lateral pelvic displacement towards the involved side and suggested lateral displacement is controlled by eccentric activity of hip abductors [10].

Study done by Kirker et al., stated impaired recovery pattern of hip abductor and adductor muscles in standing are majorly responsible for side-to-side balance stability leading to weight bearing asymmetry resulting in altered gait [11].

Present study shows extremely significant negative correlation between the anterior pelvic tilt with clinical and community walking speed and walking distance.

Anterior tilting of pelvis (2.2 ± 0.7) was more in current study as the patients were presented with more hip extensors and abdominal muscle weakness which led to decrease walking speed and walking distance when compared with lateral pelvic tilt (1.6 ± 0.7). The altered recruitment of hip extensors on the affected leg influences the pelvic stability, resulting in more anterior tilting of pelvis [5].

Study done by Yang-Ting Wu et al in (2017) found that mechanical correction technique with Kinesio tape may be used to assist the positioning of muscle, fascia tissue, or joints in the desired position. The tension applied from ASIS to the PSIS, acts as a preload, resulting in posterior tilting of the pelvis and the author interpreted that the decrease of anterior pelvic tilt after posterior pelvic tilt taping application accelerates walking speed and enhances gait ability in patients with Chronic Stroke [12].

A study done by Author Trueblood et al. suggested that major gait deviations were excessive anterior pelvic tilt and after the resisted pelvic PNF exercises the major improvement was seen in stance stability and limb advancement of the affected leg [13].

One of the studies contradict our current findings done by author Park et al (2015) who stated that pelvis intervention does not affect balance ability and stable gait. They conducted Hip Extensor Strengthening Exercise Program (HESE) on hemiplegic patients for 4 weeks and only extensor muscle was focussed and strengthened and concluded that variety of movements and muscle strengthening of hip, knee, and ankle is required to elicit the improvement in the walking speed and gait parameters [14].

In the present study, the Lateral pelvic tilt shows Quite not significant correlation with clinical and community Walking speed and walking distance.

In the current study as there was not much of lateral pelvic tilt as patients exhibited fair to good strength of hip abductors muscle which is responsible for stabilizing the pelvis and had led to reduced deviation of pelvic tilt laterally, so they were not quite significantly correlated with the clinical and community walking speed and walking distance (walking performance).

The study of Karen J. Dodd, et.al, who states that clinical evidence suggests that lateral pelvic displacement is common after Stroke and excess lateral tilt affects the weight bearing. The author found linear relationship between walking speed and amplitude of Lateral Pelvic Displacement (LPD) suggesting Stroke patients who walked faster had more normal amplitude of LPD than slower walkers, who demonstrated significantly larger amplitudes [15].

Previous study done by Seon Woong Koong (2015) reported that increased pelvic displacement in Stroke patients results in a decrease in balance ability and gait speed suggested that backward tilting of the pelvis during the swing phase shifts the body centre to behind, making it difficult for the lower limb on the paretic side to move forward leading to increase in gait time and number of steps which supports our findings [16].

Author EJ Chung et al demonstrated that Core training improves the balance of the lumbo-pelvic-hip complex, corrected postural alignments and might improve the stability of the lower trunk and pelvis which result in improving the speed and distance of walking [17].

Balance and Gait component of POMA shows very significant positive correlation with walking speed and walking distance.

When the neuromusculoskeletal system is damaged, stability maintenance, weight load adjustment, Imbalance and weakened muscle strength results in slow gait speed and short gait time, which has a negative effect on functional recovery, resulting in functional failure. [16] The neuromuscular, motor and balance impairments restrict the abilities especially during the ambulation resulting in reduced walking performance [18].

Author Grau-Pellicer M et al done study on Multimodal Rehabilitation Program (MRP) on walking speed and its impact on Community mobility and QoL in patients with subacute and chronic Stroke and stated that comfortable gait speed improved by 0.16 m/s at the end of the intervention stating that walking speed and community mobility was improved [19].

A study done by M. Iosa et al indicated that the velocity and acceleration was found altered in patients with Stroke during 6MWT, and also the gait stability was reduced during Prolonged walking which supports our findings [20].

So, in the current study as the gait component improves there will be more stability during the gait and it will positively reflect during the walking performance i.e., increasing the walking speed and distance.

The result of present study shows, walking speed assessed using 10 metre walk test shows extremely significant result between two set up. The walking speed was more in Clinical set-up (0.6 ±0.3) as compared to community set-up (0.4±0.2) in Patients with Stroke.

The mechanisms behind the same is that the patients were familiar with the clinical set up used for the study as they have been performing gait training session inside the clinic. The patients were trained on a regular basis to walk inside the clinic in a closed spaced. So, walking in an opened environment at ground level suddenly was more difficult. Also, community walkway was of concrete tiles and uneven surfaces patients becomes more conscious and alert while walking outside in the community to prevent themselves from fall. All these factors led to decrease in walking speed in the community set up [21].

Study done by Seung Heon et al (2015) assessed 10 m walk test and 6 MWT as predictors for levels of community walking and found that Gait speed was more significantly related to community walking than walking distance and suggested that gait speed is a better predictor than walking distance in moderately affected post-Stroke survivors [22].

The walking endurance was assessed using 6 MWT, which shows extremely significant result between two set up. The walking distance was less in community set-up (137.6 ± 111.2) when compared with Clinical set-up (184.1 ± 109.9). The most important determinants of community ambulation were strength and gait endurance. During community walking, patients has shown increased avoidance of environmental features as it perceived challenging to their safe mobility. Also, there was avoidance of distance dimension which may be related to reduced gait speed, to avoid risk of falls and frequent reports of fatigue [23].

A study done by Kyoung Boo Lee et al (2015) investigated the relationship between community ambulation and factors determining gait ability and suggested as the walking distance increases patients may experience increased stress and psychological burden and it might interfere with fast and co-ordinated movement [24].

Result of current study is in agreement with the findings done by Lord et al (2004) stated that walking endurance is an important factor and highly associated with the outdoor mobility and almost one third of the people were unable to walk unsupervised in their communities [25].

The result of the current study indicates that the assessment of the pelvic alignment should be incorporated as a part of routine clinical examination following stroke. The findings suggest that post Stroke there is an altered pelvic alignment which interfere with Balance and Gait and affect the walking performance. Therefore, while formulating the Rehabilitation program for patients with Stroke the area of dysfunction i.e Pelvis should be considered and Pelvic training Protocol should be incorporated which consist of use of Lower limb muscle along with Abdominal and Trunk muscle which account for change in Balance and Gait and thus improving the overall walking performance.

The study concluded that there is impact of Pelvic alignment and balance on clinical and community walking performance in patients with Stroke. This indicate that the need of early pelvic exercises should be implemented in Post Stroke patients which may lead to better rehabilitation outcomes.

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