

## ORIGINAL ARTICLE

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## EFFECT OF PELVIC TILT ON GAIT PARAMETERS IN PATIENTS WITH STROKE

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## ABSTRACT:

**Background:** Pelvic asymmetry is commonly observed in stroke subjects. There is increased anterior and Lateral Pelvic Tilt in patients with a stroke which influences the gait parameters like stride length, step length, step width and the cadence of the stroke subject. **Objectives:** 1. To measure the pelvic tilt in stroke patients. 2. To measure the gait parameters of the stroke patient.

**Materials and Methods:** It was a cross-sectional study conducted on 18 patients with stroke. Anterior and Lateral Pelvic Tilt of stroke subjects were measured using pelvic inclinometer. The deviation in pelvic tilt was measured in degrees. Patients were asked to walk on a given platform with or without assistive device. Following this, Gait parameters were measured like stride length, step length, step width and cadence. **Results:** There was a negative correlation between Anterior Pelvic Tilt and stride length, with r-value of -0.8774 and p-value <0.0001 (extremely significant). Step length and Anterior Pelvic Tilt was also correlated r = -0.7870 and p = 0.0001 (extremely significant). Step width and Anterior Pelvic Tilt was correlated which was also negative correlation r = -0.9817 and p = <0.0001 which was extremely significant and cadence and Anterior Pelvic Tilt was also negative correlation which showed r = -0.6538 and p = 0.0033 which was extremely significant. Stride length and Lateral Pelvic Tilt was correlated were correlation r was -0.8060 and significance p was <0.0001 and the test was extremely significant. Step length and Lateral Pelvic Tilt also had a negative correlation, correlation r was -0.6743 and significance p was 0.0021 which was very significant. Step width and Lateral Pelvic Tilt was correlated had the test showed negative correlation r = -0.8140 and p = <0.0001 which was also extremely significant and cadence after correlation with Lateral Pelvic Tilt also showed negative correlation were r = -0.5825 and p = 0.0112 which was significant. **Conclusion:** - It can be concluded from the study that there is a significant relationship between Anterior Pelvic Tilt, Lateral Pelvic Tilt and gait parameters in patients with stroke. **Key words:** Stroke, Pelvic tilt, Trunk control, Gait parameters.

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## INTRODUCTION

Stroke is the third major cause of mortality in the world, usually seen in the elderly population<sup>1</sup>. In India, the prevalence of strokes is estimated to be 203 per 100,000 people, and it was ranked as the sixth leading cause of disability in the year 1990 and is projected to rank fourth by the year 2020.<sup>2</sup>

The trunk is the centre of the body plays a major role in maintaining the body posture for functional movements by preparing the body, for the movement of the extremities against gravity.<sup>3</sup> Impairment in trunk performance following stroke is considered to be associated with changes in the measures of balance, gait and functional ability seen with stroke.<sup>4</sup>

Stroke patients mainly face complaining of difficulty walking resulting from paralysis. Altered pelvic alignment and asymmetrical weight bearing in bilateral lower limbs is a common problem resulting in Pelvic instability and commonly occurs during standing and walking. Inappropriate muscle activation and poor movement control around the pelvis lead to difficulty in mobility and daily functioning<sup>5</sup>.

Pelvis being the key structure that connects the trunk to lower extremities supports the weight of the body and transfers its load onto lower limbs. Also, the pelvis is a part of the lower trunk when an individual is in the sitting position, whereas it becomes a functional component of the lower limb when a person is standing and walking.<sup>6</sup> Pelvic stability refers to the ability of coordinated activity between the lower trunk and proximal hip muscles during functional balance and mobility tasks in which the pelvis serves the proximal dynamic stability as to allow for effective lower limb mobility.<sup>7</sup>

Since abnormal pelvic tilt is related to trunk control and balance, which is important for gait function, it could have effect on velocity, step length, and stride length<sup>8</sup>. Stroke people have a more forward-leaning posture with the anteriorly tilted pelvis in standing, and their altered postural alignment is related to worse trunk control and balance ability<sup>9</sup>. On observing the intersegmental trunk coordination during gait, the thoracic range of movement is more than the pelvic movement, and this transverse thorax-pelvis coordination is related to poor gait and balance ca-

pacities in people<sup>10</sup>.

After the stroke, there is a reduced anterior displacement of the body mass with an unequal weight bearing on both feet during forward reaches in the sitting position<sup>11</sup>. Most of the flexion movement is accomplished by the upper trunk, with the minimum anterior tilt of the pelvis indicating poor postural stability of lower trunk<sup>12</sup>.

Altered pelvic alignment in the standing position resulting from poor lower trunk control after stroke shall negatively influence the balance, gait and functional performance<sup>13</sup>. Additionally, it was found that pelvic mal-alignment, that is excessive lateral and Anterior Pelvic Tilt shall affect their standing weight-bearing symmetry between feet in patients after stroke<sup>14</sup>.

In post-stroke patients, an asymmetry is observed in standing and walking as they find it difficult to accept weight bearing on the most involved leg<sup>15</sup>. The reason for asymmetrical weight bearing is the inactivity of the hip abductors to work as pelvic stabilizers<sup>16</sup>. They also present with the greater excursion of the pelvis compared to healthy subjects at similar walking speeds<sup>17</sup>. This atypical muscle activation specifically at the pelvis is a characteristic feature of walking post-stroke and is a prominent and underappreciated feature.

While walking after stroke, poor lower trunk control and pelvic instability might allow for excessive lateral pelvic displacement towards the least involved side and reduced vertical movement on the most affected side<sup>18</sup>. Postural control in stroke is affected not only by the most involved lower limb but also by the inability of the contralateral leg to compensate for the undue postural demand from paretic leg.<sup>19</sup>

Lennon identified that pelvic re-education resulted in decreased Anterior Pelvic Tilt with better knee extension during stance and a more normal ankle pattern during swing phase emphasizing the importance of pelvic control and weight shift capacity towards the most affected side<sup>20</sup>. So, it becomes necessary to measure this pelvic asymmetry accurately. Hence the aim of this study is to determine the association among the pelvic tilt and gait parameters in patients with stroke.

## MATERIALS AND METHODOLOGY

This cross-sectional study was approved by the Institutional Research Ethics Committee of Dr Vithalrao Vikhe Patil Foundations College Of Physiotherapy Ahmednagar India. According to the prevalence of stroke patients in the institute and sample size calculation, 18 subjects were included in the study. The material needed for the study was pelvic inclinometer, powdered chalk and measuring tape. The aim and procedures of the study were explained to the volunteering subject, following that written informed consent was obtained from those who were interested to participate in the study. Before commencing of the study demographic data of the subjects was recorded. Standardized instructions to patients were given to the patients to stand normally and follow the command given by the investigator. The inclusion criteria was the patients with the age of 30-70 years with Brunnstrom stage of motor recovery for the affected lower limb range of 3-5, ambulatory but with residual gait deficit as defined as a visual gait abnormality (including those who use a cane or walker), ability to understand and follow simple verbal instructions, independent gait ability to walk at least 15 m without assistance, with Anterior Pelvic Tilt of more than 13°. Patient who were unable to walk without assistance, who had neurological problems other than stroke that would interfere with gait and balance control, patients with disability in visual, auditory, and vestibular organs, who had history of orthopaedic diseases, such as contracture, fracture, or arthritis in lower limbs, patients who had Pain, limited motion, or weakness in the non-paretic lower extremity that would affect the performance of daily activities were excluded from the study.

## PROCEDURE

The patient was asked to stand normally and relaxed with loose clothing with no footwear on the level floor. Their anterior and Lateral Pelvic Tilt was measured with pelvic inclinometer<sup>21</sup>. An inclinometer was placed at the pelvis with one point on ASIS and other point on PSIS for anterior and posterior tilt measurement. The placement of inclinometer was different for lateral tilt i.e. Parallel to the ground on both the PSIS. Gait parameters were assessed by asking the patients 1<sup>st</sup> to place their foot in powdered

chalk and then stride length (distance between 2 successive heel strikes), step length (distance between 2 successive contacts of same foot) and stride width (lateral distance of 2 consecutive foot contact) was measured using measuring tape along with it cadence of patients was measured by asking the patient to walk for complete 1minute and number of steps in 1minute was counted. Also the Functional Gait Assessment Scale<sup>22</sup> was taken which had various components like gait level surface, change in gait speed, gait with horizontal head turns, gait with vertical head turns, gait and pivot turn, step over obstacles, gait with a narrow base of support, gait with eyes closed, ambulating backwards and steps. Each component has 4 subscores- :3-normal, 2- mild impairment, 1-moderate impairment, 0- severe impairment.



**Fig 1 :** Measurement of Anterior tilt



**Fig 2:** Measurement of Lateral tilt

## RESULTS

The data was collected in the form of the demographic characteristic of patients. Measurement of anterior and Lateral Pelvic Tilt in degrees, measurement of various gait parameters such as step length stride length step width and cadence in cm. cadence was measured as no of steps taken in 1minute. Functional gait abnormality scale scoring was done by observation of patient while performing the various task as described in the scale.

**Table 1 :** Demographic characteristic of participants

Outcome	Mean +-SD
Age (yrs)	55.16±12.08
Duration of stroke (months)	6.77±2.23
M:F (ratio)	2:1
LT: RT (n)	7/11

**Table 2:** Correlation between Gait parameters and APT

Outcome	mean±SD	correlation r	Significance p	Result
stride length	43.27±12.62	-0.8774	<0.0001	Extremely Significant
step length	21.77±6.31	-0.7870	0.0001	Extremely Significant
Cadence	35.77±11.71	-0.6538	0.0033	Extremely Significant
step width	10.38±2.68	-0.9817	<0.0001	Extremely Significant

**Table 3 :** correlation and significance between LPT and gait parameters

Outcome	mean±SD	correlation r	Significance p	Result
stride length	43.27±12.62	-0.8060	<0.0001	Extremely significant
step length	21.77±6.31	-0.6743	0.0021	very significant
Cadence	35.77±11.71	-0.5825	0.0112	Significant
step width	10.38±2.68	-0.8140	<0.0001	Extremely Significant

## DISCUSSION

The primary aim of the study was to measure the pelvic tilt and to measure the gait parameters in stroke patients. 18 stroke patients were taken in the study where male-female ratio was 2:1. Patients with age of 30 to 80 years were included which showed mean ± SD (55.16±12.08) years. Patients were of different duration mean ± SD (6.77±2.23) months. Angle between ASIS and PSIS on the same side was measured with pelvic inclinometer for Anterior Pelvic Tilt and for Lateral Pelvic Tilt inclinometer was placed on both PSIS. Gait parameters like stride length step length, step width was measured by tape and cadence was measured by counting the steps. Pelvic tilt was correlated with gait parameters. The result showed that there was a negative correlation between Anterior Pelvic Tilt and stride length, with an r-value of -0.8774 and p-value <0.0001 which showed the correlation test is extremely significant. Step length and Anterior Pelvic Tilt was also correlated r = -0.7870 and p =0.0001 there was negative correlation and the result showed extremely significant. Step width and Anterior Pelvic Tilt was correlated which was also negative correlation r = -0.9817 and p = <0.0001 which was extremely significant and cadence and Anterior Pelvic Tilt was also negative correlation which showed r = -0.6538 and p = 0.0033 which was extremely significant. Correlation between Lateral Pelvic Tilt and gait parameters was also done.

Stride length and Lateral Pelvic Tilt was correlated were correlation r was -0.8060 and significance p was <0.0001 and the test was extremely significant. Step length and Lateral Pelvic Tilt also had a negative correlation, correlation r was -0.6743 and significance p was 0.0021 which was very significant. Step width and Lateral Pelvic Tilt was correlated had the test showed negative correlation r =-0.8140 and p=<0.0001 which was also extremely significant and cadence after correlation with Lateral Pelvic Tilt also showed negative correlation were r= -0.5825 and p=0.0112 which was significant.

There was a significant relationship between gait parameters and Anterior Pelvic Tilt as evidence from the results of this study. This is consistent with the previous articles available in the literature. The possible mechanism behind this being that with an increase in Anterior Pelvic Tilt, the foot is placed a little beyond the other foot but the lack of hip flexion control due to extensor spasticity prevents it from being taken much forward.

Though the Anterior Pelvic Tilt is increased it may not mean that the hip flexors are overacting as there is a common belief of the presence of extensor synergy in lower limb<sup>12</sup>. Hence though ideally with increased Anterior Pelvic Tilt the step length should increase, in reality, it is getting reduced. Therefore it is important to investigate the status of hip flexors muscles in terms of tone or voluntary control grading so as to establish the relationship between hip flexor activity and associated increased Anterior Pelvic Tilt.

Step width may reduce in the presence of Anterior Pelvic Tilt and more importantly in the presence of Lateral Pelvic Tilt which is a result of reduced hip abductor activity.<sup>21</sup> This reduced hip abductor activity may allow the adductors to pull the leg in the direction of adduction and may not allow the leg to go much beyond the midline as it could happen normally thereby reducing the step width.

Anterior Pelvic Tilt also results in reduced cadence as shown by the results of this as well as the previous studies.<sup>22,23,24</sup> However, the mechanism of reduced cadence due to increased Anterior Pelvic Tilt cannot be explained it needs further investigation in terms of various muscle activity levels in the lower extremity.

Though much emphasis is always given on the Anterior Pelvic Tilt, the Lateral Pelvic Tilt may also cause significant interference in the observed values of gait parameters. In the present study, Lateral Pelvic Tilt has resulted in altered gait parameters which can be explained by the fact that in absence of hip abductor activity the leg may not move in the desired direction and to the desired amount<sup>13,15</sup>. Further, it is necessary to quantify the amount of Lateral Pelvic Tilt so that the relationship can be established more effectively. Similarly, it would also be of great interest if the relationship between the extent of pelvic tilt and the level of hip abductor muscle activity is explored. A possible limitation of this study can be the heterogeneous sample of patients with stroke and unavailability of the standardised instrument, the shorter time span for the conduction of research.

## CONCLUSION

It can be concluded from the study that there is a significant relationship between Anterior Pelvic Tilt, Lateral Pelvic Tilt and gait parameters in patients with stroke. But the further relationship between muscle activity and gait parameters with a pelvic tilt with confounding factors needs to be explored.

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