Analysis of gait pattern deviations among chronic post stroke patients

Aroosa Tariq, Sundus Akhtar, Misbah Marryam, Muhammad Umar

Departments of Physiotherapy, Riphah College of Rehabilitation Sciences, Islamabad, Benazir Bhutto Hospital, Rawalpindi, Holy Family Hospital, Rawalpindi and Department of Neurology, Pakistan Institute of Medical Sciences, Islamabad, Pakistan

Objective: To determine the abnormalities of different parameters of gait and to determine the association of spasticity with them in chronic post stroke population.

Methodology: It was a cross sectional descriptive study conducted over a duration of 3 months in 2017 at Pakistan Institute of Medical Sciences, Islamabad and Railway General Hospital, Rawalpindi and included 104 chronic stroke patients using non probability purposive sampling technique. Patients presenting with both ischemic and hemorrhagic stroke, both genders having age of 25 year to 75 years, patients who had suffered from stroke in past 6 months at time of data collection were included in the study. Those patients who had weakness due to any tumor, Guillain Barre Syndrome, peripheral nerve injury, multiple sclerosis or traumatic brain injury were excluded from the study. Dynamic gait index, Modified Ashworth scale, 10 meter walk test and temporospatial characteristics like, step length, stride length, step width and cadence were used as data collection tools. Data analysis was performed by SPSS version 21.

Results: The mean age of patients was 55.56±13.46 years. Marked gait deviations were observed including decreased step length (12.75±2.23) inches, stride length (22.99±4.11) inches, cadence (66.92±20.31) steps/min and increased step width (8.15±1.58) inches. Increased tone in lower limb muscles was found in the patients on modified Ashworth scale and decreased gait velocity by 10 meter walk test (0.49±0.23) m/s. Greater risk of fall was observed by dynamic gait index (13.5±5.22).

Conclusion: There were marked deviations of gait in post stroke population in chronic stage. These included changes in step length, stride length, step width and cadence. There were also changes in the scores of dynamic gait index and 10 meter walk test which showed an alteration in gait speed and adaptability thus limiting the independence of stroke patients. (Rawal Med J 202;45:310-313).

Keywords: Dynamic gait index, gait deviations, Modified Ashworth scale, stroke.

INTRODUCTION
Stroke is the major cause of disability and death worldwide. WHO defined stroke as a quickly advancement of clinical sign of focal disturbance of cerebral function that remains more than 24 hours or leading to death without observable cause other than of vascular origin.¹ Stroke can be ischemic or hemorrhagic. Transient ischemic attack (TIA) is defined as temporary blockage of blood blow to brain and lasting less than 24 hours.² The number of global deaths is estimated to increase to 6·5 million in 2015 and to 7·8 million in 2030³ and significant disability.⁴ WHO reported 5.5 million deaths because of stroke in 2002, and approximately 20% of these deaths occurred in South Asia.⁵ In Pakistan, the number of deaths has been estimated to be 350,000 annually due to stroke.⁶ Stroke results in multiple impairments, especially proprioception and stereognosis.⁷ Almost 65% of stroke survivors suffered in some degree of swallowing problem,⁸ 50% had marked intellectual impairment⁹ and 75% suffered from upper extremity impairments.¹⁰ Gait deviations in stroke patients related to trunk and pelvis, is forward trunk posture due to weak hip extension and flexion contracture, hip Trendelenburg gait due to weak abductors and scissoring due to spastic adductors. Equinus gait, varus foot, unequal step length and lack of dorsiflexion at ankle and foot are seen. Insufficient projection of the leg during pre-swing,
increased percentage of swing time, and reduced knee flexion at toe-off and mid swing in the affected limb and related complementary strategies (pelvic hiking and swing phase propulsion and circumduction of the affected limb) are also some of the gait deviations in chronic stroke. The current study was designed to find the residual deficits in gait of post stroke patients so that an appropriate rehabilitation program could be designed keeping in mind the deviations.

**METHODOLOGY**

This cross sectional descriptive study was conducted on 104 chronic stroke patients. Patients with 25 to 75 years of age were assessed using non probability purposive sampling technique. The study was carried out from February to July 2017 in Railway General Hospital and Pakistan Institute of Medical Sciences, Islamabad after getting permission from ethical committee of both institutes. An informed consent was taken from all patients. Patients included in the study were those presenting with both ischemic and hemorrhagic stroke, both genders having age of 25 year to 75 years, patients who have suffered from stroke in past 6 months. While those patients who have weakness due to any tumor, Gullian Barre syndrome, peripheral nerve injury, multiple sclerosis, traumatic brain injury were excluded from the study.

Data about gait alterations was collected by using Dynamic gait index to evaluate functional stability during gait activities and to evaluate their risk of falling. 10 meter walk test was used for gait speed assessment and Temporospatial characteristics of gait like step length, stride length, step width and cadence were also measured. For measuring spasticity, modified Ashworth scale (MAS) was used. The data was collected from each patient once only in 15-20 minutes.

**Statistical Analysis:** After collection of data, it was analyzed using SPSS version 21. Demographics and descriptive data was evaluated in the form of frequencies and means while for the evaluation of correlation, Spearman rank correlation was used. P<0.05 was considered statistically significant.

**RESULTS**

Out of 104 patients, 67(64.4%) were male and 37(35.6%) female. Mean age was 55.56±13.46 years. Ischemic stroke was present in 58(55.8%) patients and hemorrhagic stroke in 46(44.2%). Mean of step length was 12.75±2.23 inches, stride length was 22.99±4.11 inches, step width was 8.15±1.58 inches and cadence was 66.92±20.31 steps per minute. Modified Ashworth scale showed highest frequency of patients were in grade 1+ of spasticity in lower limbs (Table 1).

<table>
<thead>
<tr>
<th>Grades</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>29</td>
<td>27.9%</td>
</tr>
<tr>
<td>1+</td>
<td>46</td>
<td>44.2%</td>
</tr>
<tr>
<td>2</td>
<td>27</td>
<td>26.0%</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>1.9%</td>
</tr>
</tbody>
</table>

Table 2. Dynamic gait index showing deviations of gait in chronic stroke patients.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Gait level surface</th>
<th>Change in gait speed</th>
<th>Gait with Horizontal head turns</th>
<th>Gait with Vertical head turns</th>
<th>Gait and pivot turn</th>
<th>Step over obstacle</th>
<th>Step around obstacles</th>
<th>Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0(0%)</td>
<td>7(6.7%)</td>
<td>5(4.8%)</td>
<td>12(11.5%)</td>
<td>8(7.7%)</td>
<td>11(10.6%)</td>
<td>4(3.8%)</td>
<td>10(9.6%)</td>
</tr>
<tr>
<td>1</td>
<td>17(16.3%)</td>
<td>29(27.9%)</td>
<td>36(34.6%)</td>
<td>44(42.3%)</td>
<td>46(44.2%)</td>
<td>49(47.1%)</td>
<td>31(29.8%)</td>
<td>32(30.8%)</td>
</tr>
<tr>
<td>2</td>
<td>47(45.2%)</td>
<td>42(40.4%)</td>
<td>45(43.3%)</td>
<td>40(38.5%)</td>
<td>39(37.5%)</td>
<td>37(35.6%)</td>
<td>52(50%)</td>
<td>50(48.1%)</td>
</tr>
<tr>
<td>3</td>
<td>40(38.5%)</td>
<td>26(25%)</td>
<td>18(17.3%)</td>
<td>8(7.7%)</td>
<td>11(10.6%)</td>
<td>7(6.7%)</td>
<td>17(16.3%)</td>
<td>11(10.6%)</td>
</tr>
</tbody>
</table>
Restricted time duration of the study and permission issues from different hospitals was a major constraint for data collection. Due to less localized space of physiotherapy departments in different hospitals, difficulties were encountered while taking measurements. Future studies should be conducted with large sample size and with larger time durations.

**CONCLUSION**

There were marked deviations in post stroke population in chronic stage. These deviations include changes in step length, stride length, step width and cadence. There were also changes in the scores of dynamic gait index and 10 meter walk test which showed an alteration in gait speed and adaptability thus limiting the independence of stroke patients.

### Table 3. Spearman rank correlation between different variables.

<table>
<thead>
<tr>
<th>Correlation variables</th>
<th>P value</th>
<th>Correlation Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAS and DGI at baseline</td>
<td>0.57</td>
<td>-0.057</td>
</tr>
<tr>
<td>MAS and 10 meter walk test</td>
<td>0.375</td>
<td>-0.091</td>
</tr>
<tr>
<td>MAS and step length</td>
<td>0.019*</td>
<td>+0.23</td>
</tr>
<tr>
<td>MAS and stride length</td>
<td>0.007**</td>
<td>+0.264</td>
</tr>
<tr>
<td>MAS and cadence</td>
<td>0.423</td>
<td>-0.079</td>
</tr>
<tr>
<td>MAS and step width</td>
<td>0.48</td>
<td>+0.070</td>
</tr>
</tbody>
</table>

*=P value<0.05 **=P value<0.01 MAS: Modified Ashworth Scale DGI: Dynamic gait index

10 meter walk test was found to be 0.49±0.23 m/sec, that is much lower than that of normal population i.e. 1.49 m/sec. Dynamic gait index was found to be 13.5±5.22. Such low values showed increase in risk of fall (Table 2). A weak positive correlation was found in between step length and Modified Ashworth scale and stride length and modified Ashworth scale with P value < 0.05. All other parameters showed non-significant results (Table 3).

**DISCUSSION**

Our study showed marked deviations in temporospatial characteristics of gait among chronic post stroke patients along with increased risk of fall on dynamic gait index. Sandra et al reported similar results. Another study by Kim et al reported that after stroke, there are compensatory motions at different joints in response to decrease range of motion of lower limb which produces marked deviations in all the parameters of gait including step length, stride length, cadence and step width.

Kara et al compared step length, stride length, step width, double support time, stance time, swing time and swing to stance time ratio of normal healthy participants with that of the stroke participants and reported marked asymmetry in stroke patients.

Fulk et al found that gait speed is a reliable measure of walking ability in stroke and it is more sensitive to change in stroke patients who require physical assistance.

Foley et al did a meta-analysis to find the effects of Botox in decreasing spasticity of lower limb after stroke and determined its effects on gait velocity. They reported an increase in the gait velocity of stroke patients after Botox that decreased spasticity. This shows spasticity has a negative impact on gait of the patients after stroke. Similarly, in the current study spasticity was also observed in chronic post stroke patients affecting the velocity of the gait as shown by deviations on 10 meter walk test. However, when correlation was evaluated between gait velocity and modified Ashworth scale, no significant relationship was found. The reason behind this may be as patients in current study had more frequent in grade 1+ of spasticity on modified Ashworth scale so that might not affect gait in such a way that produces gait alterations.

Roardink et al did a study on hemiplegic stroke patients and reported that step length asymmetry develops after stroke that lead to improper placement of foot in forward direction and trunk progression thus causing major impairments in the gait leading to compensatory gait strategies. The results of current study also showed asymmetry in step length that may be a cause of abnormal readings on different assessment scales used for gait analysis. Restricted time duration of the study and permission issues from different hospitals was a major constraint for data collection. Due to less localized space of physiotherapy departments in different hospitals, difficulties were encountered while taking measurements. Future studies should be conducted with large sample size and with larger time durations.

**CONCLUSION**

There were marked deviations in post stroke population in chronic stage. These deviations include changes in step length, stride length, step width and cadence. There were also changes in the scores of dynamic gait index and 10 meter walk test which showed an alteration in gait speed and adaptability thus limiting the independence of stroke patients.
REFERENCES