International Journal of Health Sciences and Research
www.ijhsr.org ISSN: 2249-9571

Original Research Article

Relationship between Pelvic Alignment Variables on Symmetrical Lower Limb Weight Bearing in Post Stroke Survivors- A Cross Sectional Observational Study

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ABSTRACT

Background: Many studies have already been conducted on relation between symmetrical lower limb weight bearing and pelvic alignment and its effect on trunk control, motor recovery, balance, functional mobility but there is limited/no evidence on pelvic alignment variables and their influence on symmetrical lower limb weight bearing in post stroke survivors. Current study aims at finding the influence of pelvic alignment variables on symmetrical lower limb weight bearing in post stroke survivors.
Methods: Out of 583 subjects, 100 subjects were enrolled in this study, if they met the inclusion criteria. The subjects were assessed for the weight distribution on both the lower limbs using two identical digital weighing machines. The pelvic variables were measured using the Palm device. Other assessments include functional scales like Berg Balance Scale, Trunk Impairment Scale and Lower Extremity Functional Index in addition to tone and power examination.
Results: There is mild to strong correlation between different parameters of pelvic alignment, and lower limb weight bearing. Hip rotation, and also the foot arches, has an effect on the pelvic parameters. Imbalance in weight bearing can also be a result of polarity in these variables
Conclusion: This study concludes that pelvic variables do have an effect on lower limb weight bearing in post stroke survivors.

Key words: Pelvic alignment variables, symmetrical lower limb weight bearing, post stroke survivors, pelvic tilts, hip hike, pelvic rotations.

INTRODUCTION

According to World Health Organization, stroke is defined as, "Rapidly developing clinical signs of focal (global) interruption to cerebral function, with symptoms lasting for 24hours or longer or leading to death with no evident cause other than that of vascular origin." (WHO)

Stroke is a global health problem, [(1)] and major cause of death and disability in adults. [(2)] Globally, about 20 million people suffer from stroke each year; 5 million may die as a consequence and 15 million survive; of those who survive, 5 million may be disabled due to stroke.

According to the India Stroke fact sheet, the estimated age-adjusted prevalence rate for stroke ranges between 84-262/100000 in rural and between 334-424/100000 in urban areas. [(3)]

Stroke related hemiparetics also exhibit asymmetry in standing posture and walking due to motor weakness, asymmetric muscular tone and somatosensory, loss of range of motion, [4] deficits in lower extremities which leads to balance impairment, postural sway, disordered gait and increased probability of falls.

Altered pelvic alignment and asymmetrical weight bearing onto lower limbs are the most common findings observed after stroke. [5] This occurs due to strategies of postural control influenced by mechanisms around the hip and ankles. [6] In hemiparesis, one of the lower limbs is overloaded in response to a decreased efficiency of the hip and ankle strategies for postural adjustments. [7][8]

The foot factors that have an important role in the standing posture are sub-talar joint pronation, calcaneus eversion, plantar flexion, and talus adduction. [9] Talus adduction also causes a functional reduction in length to induce abnormal alignment of the pelvic. [10] Additionally, presence of bilateral calcaneal eversion causes internal rotation at the hip joint, which increases pelvic ante version and lumbar lordosis, [11] and may also result in scoliosis. [12][13]

The palpation meter (PALM device) is a pelvic leveling device that combines the features of both, a caliper and an inclinometer, and this device has been tested for its intra- rater and inter-rater reliability in measuring pelvic obliquity. [14]

For the measurement of symmetrical weight transfers, digital weighing scales are used, as they are less expensive, and reliable, and are considered a clinically potential tool.

Trunk control can be clinically measured using the trunk impairment scale (TI scale), described by the Verheyden, as it is found to have good psychometric properties in stroke cases. [15] Impairments in balance will be scored using the Berg Balance Scale, as its reliability has already been established in stroke cases.

Many studies have already been conducted on relation between symmetrical lower limb weight bearing and pelvic alignment and its effect on trunk control, motor recovery, balance, functional mobility but there is limited/no evidence on pelvic alignment variables and their influence on symmetrical lower limb weight bearing in post stroke survivors. Current study aims at finding the influence of pelvic alignment variables on symmetrical lower limb weight bearing in post stroke survivors.

Participants:

Patients diagnosed with first ever stroke, Stroke patients without any visual, auditory or vestibular dysfunction, both genders aged between 30-70 years, ability to follow verbal commands and walk 10m without any mobility aids, subjects who are able to stand without support with feet apart for more than 30 seconds, stroke subjects with good cognition, and the subjects willing to participate in the study, were included in this study. Exclusion of subjects with brainstem or cerebellar stroke, sensory impairment, visual field defect, musculoskeletal disease affecting standing balance, patients with perceptual and cognitive deficits, contractures of the hip and knee flexors, recent fractures/ surgeries of lower extremities. Written informed consent were obtained. The study was approved by the ethical committee of Nizam’s Institute of Medical Sciences.

Study Procedure:

Digital weighing scale: Two identical digital weighing scales were used to document weight bearing. Each scale had a precision of 0.1 kg calibrated prior to use by loading with certified weights. The scales were placed side by side. Each scale had a footprint silhouette on its surface to assure consistent foot placement by the subjects. The silhouettes were toed out 10 degrees and 20cm apart at the position of the first metatarsal heads. Subjects were seated in a chair with the scales in front of them. They were instructed to stand up. Thirty seconds after attaining independent standing they were instructed to step on the scales. After placing their feet on the silhouettes and being reminded to visually observe a target circle (placed on a pole) l.5m from the floor and l.5m anterior to the scales, they were asked if they were comfortable or not.

The chief investigator then counted. "One, two, three, four, go". Instantaneous readings were taken from the digital displays of each scale by an assistant on the "go" command. The subjects were then instructed to step back off the scales. The subjects were instructed a second and third time to step on and off the scales in the same manner for a second and third reading. A 10 second interval was allowed between each weight bearing stance trial on the scales.

Palm meter:

Iliac crest heights

Before measuring the iliac crest height, the error due to lateral weight shifting was minimized by placing the feet of the patient at the width of the femoral heads. This was achieved in adults by using a standard 15cm/6’’ gap between the feet. The index finger was placed on the iliac crest heights and the readings were noted.

Pelvic tilts

The relaxed pelvic tilt angles were determined by palpating ASIS and PSIS, on one side, the anterior and posterior pelvic tilt angles were measured by keeping the index finger in contact with ASIS, and PSIS, while the patient moves to the either ends of the range. Anterior pelvic tilt and posterior pelvic tilt range of motion was calculated by subtracting the relaxed tilt angle from the maximal anterior pelvic tilt, and posterior pelvic angles.

Statistical Analysis: The SPSS software (version 21.0) and Excel 2013 were used to analyze all the data. Pearson’s correlation coefficient was used to test the correlation of pelvic alignment factors and weight variables. Student’s t-test was used for sample statistics of the variables. Mild to strong correlation was found between different parameters.

Table 1: shows the descriptive statistics, and t-test values of variables.

	N	Mean ± SD	Std. Error	t value
AWT	100	26.78±6.51	0.65	41.12
UA WT	100	38.73±6.87	0.69	56.39
A PTILT	100	9.80±4.26	0.43	23
UA PTILT	100	7.24±3.67	0.37	19.7
P HIKE	100	5.13±2.56	0.26	20
A PROT	100	26.03±2.60	0.26	99.99
UA PROT	100	24.23±2.99	0.299	80.82
A KNEE FLEX	100	2.89±3.36	0.336	8.6
UA KNEE FLEX	100	0.55±1.87	0.187	2.95

RESULTS

Out of the total recruited patients, 75 were males and 25 were females. This study had 57 subjects with left side affected, out of which 13 were females, and 44 were males.

There were 43 subjects whose right side was affected, out of which 12 were females, and 31 were males.

Out of a total 100 subjects, 3 subjects – (1 female, and 2 males) had neutral pelvis. 72 subjects (17 females, and 55 males) showed anterior pelvic tilt, and 25 subjects (7 females, and 18 males) showed posterior pelvic tilt.

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Out of the 100 subjects, 6 subjects (2 females, 4 males) were reported to have a neutral pelvis. 51 subjects, out of which 11 female, 40 males were noted to have a left sided pelvic hike. 43 subjects – 12 females, 31 males, were noted to have a right sided pelvic hike.

13 females, 44 males (54 subjects) were reported to have a left sided pelvic rotation, and 12 females, 31 males (43 subjects) were reported to have a right sided pelvic rotation.

42 subjects - 11 females, 31 males, showed left sided pelvic rotation of the unaffected side, and 58 subjects – 14 females, and 44

males - showed right sided pelvic rotation of the unaffected side.

23 subjects (7 females, 16 males) had a flat arch on the affected side, 54 subjects (12 females, 42 males) had high arch, and 23 subjects (6 females, 17 males) appeared to have a normal arch.

Most of the arches of the unaffected side had a normal arch (61 subjects – 16 females, and 45 males), 16 subjects (1 female, and 15 males) had a high arch and 23 subjects (8 females, and 15 males) had a flat arch on the unaffected side.

Correlations of the affected side with other parameters of the affected side -

Affected weight and other parameters:

There is significant positive relation between affected weight and rotation component on the affected side (Pearson coefficient 0.171) i.e. a decrease in the weight bearing on the affected side will decrease the pelvic rotation on the affected side and vice versa.

Affected weight has a negative correlation with knee flexion component on the affected side (Pearson coefficient -0.132), i.e. a decreased weight bearing on the affected limb will increase the flexion component on the affected side and vice versa.

There is a weak positive statistical correlation between affected weight and pelvic tilt on the affected side as the Pearson’s Correlation Coefficient is 0.06 suggesting a weaker relation and vice versa.

Statistically, there is no significant correlation between affected weight and pelvic hike as the Pearson Correlation coefficient is 0.01 that indicates a weak relation. However, had the sample size been larger, the analysis would have shown a better correlation. As per literature evidence, there is a negative correlation between pelvic hike and weight bearing on affected side.

Pelvic hike and other parameters:

Pelvic hike correlates positively with pelvic tilt which implies an increase in pelvic hike of the affected side increases the pelvic hike, and vice versa. However, the correlation is weak (Pearson coefficient value 0.076)

Pelvic hike correlates negatively with pelvic rotation of affected side (Pearson coefficient -0.110) which implies an increase in pelvic tilt of the affected side decreases the pelvic rotation of the affected side, and vice versa.

Pelvic hike correlates negatively with affected knee flexion (Pearson coefficient -0.021) i.e. if the hike increases, the affected knee flexion increases and vice versa.

Affected Pelvic tilt and other parameters:

Affected pelvic tilt has a negative correlation with affected pelvic rotation (Pearson coefficient -0.162) i.e. more the tilt of the pelvis, less is the rotation component.

Affected pelvic tilt has a positive correlation with affected knee flexion (Pearson coefficient 0.071) i.e. when affected pelvic tilt increases, the knee flexion component on affected side may also increase.

Affected pelvic rotation with other parameters:

Affected Pelvic rotation correlates negatively with pelvic tilt and pelvic hike which implies an increase in pelvic rotation of the affected side decreases the pelvic tilt and pelvic hike, and vice versa.

Affected knee flexion with other parameters:

Knee flexion on the affected side has a positive co-relation with pelvic tilt and pelvis rotation where an increase in the degree of knee flexion causes an increase in the pelvic tilt and rotation.

Meanwhile it has a negative co-relation with pelvic hike and weight distribution on lower limb. An increase in knee flexion increases the pelvic hike thereby decreasing the limb loading on the affected side.

Correlations of the unaffected side with the parameters of the affected side -

Unaffected weight side with other parameters of the affected side:

The unaffected weight has a positive correlation with affected pelvic tilt (Pearson coefficient 0.103) i.e. an increased weight bearing on the unaffected side increases the pelvic tilt on the affected side. This finding correlates with literature evidence.

The unaffected weight has a negative correlation with pelvic rotation on affected side (Pearson coefficient -0.059) and affected knee flexion (Pearson coefficient -0.113) i.e. an increased weight bearing on the unaffected side may decrease the rotation of affected pelvis and affected knee flexion component.

Unaffected pelvic tilt with other parameters of the affected side:

Unaffected pelvic tilt correlates positively with weight (Pearson coefficient 0.024) and which implies that an increase in pelvic tilt of the unaffected side may increase the weight bearing on the affected side, and vice versa.

Unaffected pelvic tilt correlates positively with pelvic hike (Pearson coefficient-0.077) which implies an increase in pelvic tilt of the unaffected side increases the pelvic hike, and vice versa.

Unaffected pelvic tilt correlates negatively with pelvic rotation of affected side(Pearson coefficient -0.152) which implies an increase in pelvic tilt of the unaffected side decreases the pelvic rotation of the affected side, and vice versa.

Unaffected pelvic tilt has a strong positive correlation (Pearson coefficient 0.895, significance 0.00) with affected pelvic tilt. This means that it increases when affected tilt increases.

Unaffected pelvic with other parameters of the affected side:

Unaffected pelvic rotation has a strong positive correlation with the pelvic rotation of the affected side (Pearson's coefficient 0.750, significance 0.00), i.e. any increase in rotatory component of one side will increase the rotation of the other side.

Unaffected pelvic rotation has strong positive correlation with affected weight (Pearson coefficient 0.309, Significance 0.002), which implies that an increase in pelvic rotation of the unaffected side increases the weight loading on the affected side, and vice versa.

Unaffected pelvic rotation has a weak negative correlation with affected pelvic tilt (Pearson's correlation -0.143) i.e. when the unaffected pelvic rotation decreases pelvic tilt on affected side increases and vice versa.

Unaffected pelvic rotation correlates negatively with pelvic hike (Pearson's coefficient -0.217, significance 0.03) which implies an increase in pelvic rotation of the unaffected side decreases the pelvic hike, and vice versa.

Unaffected knee flexion with other parameters of the affected side:

Knee flexion correlates negatively with weight and affected pelvic rotation, which implies that an increase in knee flexion of the unaffected side decreases the weight loading on the affected side and also the affected pelvic rotation and vice versa.

Knee flexion correlates positively with pelvic tilt and pelvic hike of affected side which implies an increase in knee flexion of the unaffected side also increases the pelvic tilt and hike on the affected side, and vice versa.

Correlations between parameters of affected weight on the unaffected lower limb -

Correlations of affected weight with unaffected lower limb parameters:

The affected weight has a highly significant positive correlation with unaffected pelvic rotation (Pearson coefficient 0.309, significance 0.002) i.e. if the affected weight decreases, the unaffected pelvic rotation increases and vice versa.

Affected weight has a weakly positive correlation with the unaffected pelvic tilt i.e. when the weight on affected side decreases, the unaffected pelvic tilt may also decrease.

Affected weight has a negative correlation with unaffected knee flexion i.e. when the weight on affected side decreases, the unaffected knee flexion increases.

DISCUSSION

This study was done to find out the co-relation between pelvic alignment and its effect on weight distribution on the lower limbs. This study also aimed to find out the parameters that influence the pelvis alignment.

The patients were included in the study with their consent following which a detailed assessment of the patients was done. They were assessed for the weight distribution on the lower limbs using two identical digital weighing machines. The pelvic variables were measured using the Palm device. Other assessments included functional scales like Berg Balance Scale, Trunk Impairment Scale and Lower Extremity Functional Index in addition to tone and power examination.

Explicitly explaining, out of the 100 subjects, 72% patients showed anterior pelvic tilt of the affected side, 51% patients showed pelvic hike of the affected side, 57% showed affected side pelvic rotation, and 54% subjects had high arches on the affected lower limb. Patients were bearing less weight on the affected side lower limb.

The abnormal pelvic tilt noted in this study, is supported by a study of Myoung-Kwon Kim, et.al, [16] which states that abnormal pelvic tilt occurs in stroke patients, and can be attributed to trunk control, gait function, and balance, following stroke.

This pelvic hiking is supported by the study done by Suriliraj Karthik Babu, et.al, [17] who concluded that excess lateral pelvic tilt/ pelvic hike towards the affected side, also affects the weight bearing.

This also correlates well with the study of Karen J. Dodd, et.al, [18] who states that clinical evidence suggests that lateral pelvic displacement is common after stroke

All the subjects had a pelvic rotation component on the affected side out of which 57 had left sided rotation and 43 had a right sided rotation.

A study by Geert Verheyden, et.al, [19] concludes that post-stroke people have altered/reduced sacral sagittal alignment, and sacral postural alignment, in standing.

There was a rotatory component in the pelvis of the unaffected side as well. In the left hemiparetics, out of the total 57 patients, only 42 patients had an associated rotation of the unaffected pelvis towards left while the remaining 15 patients had a rotation to the right.

However, all the right hemiparetics had a rotation of the unaffected pelvis to the right.

54% of the subjects had high arches on the paretic lower limb. This part of our study is consistent with the study of Gwon UK Jang, [20] who concluded that the amount of spasticity can affect the supination of the foot; more the spasticity, more the supination/high arches of the foot.

All the patients had a decreased weight bearing on the affected side lower limb. A study done by Richard W Bohannon, [21] concluded that in bilateral stance with more than 30s weight bearing, the non-paretic lower limb had greater weight bearing ability.

Limitations: The foot component could not be assessed properly due to lack of proper assessment tools. Owing to the increased incidence, a larger sample would have yielded a better statistical outcome. Lastly, Postural parameter could not be included in this study.

Scope of further study: This study was directed towards lower limb weight bearing and its effect on the pelvic parameters, another study with an aim of finding the upper-limb and trunk involvement can also be implemented. Also, study involving the posture, foot and the hip components can be conducted as an extension to this study to complete the lower limb variables.

CONCLUSION

This study was done to find out the co-relation between pelvic alignment and its effect on weight distribution on the lower limbs. This study also aimed to find out the parameters that influence the pelvis alignment. It also aimed to co-relate the impact of an altered pelvic alignment on the knee and foot components.

In conclusion, though there are noticeable changes in all the pelvic parameters, they are mildly significant, statistically. Pelvic tilt appears to be mildly correlated to the other parameters, however, pelvic rotation, and knee flexion showed significant changes statistically.

Conflict of interest: None.

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How to cite this article: Kiran LS, Balne NK, Prasad GL. Relationship between pelvic alignment variables on symmetrical lower limb weight bearing in post stroke survivors- a cross sectional observational study. Int J Health Sci Res. 2019; 9(10):83-89.

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