

# **Quantification of Seated Functional Axial Rotation in Stroke Patients**

Karajgi Asmita<sup>1</sup>, Ahuja Kiran<sup>2</sup>, Yardi Sujata<sup>3</sup>

Professor, School of Physiotherapy, D.Y.Patil University, Navi Mumbai, India<sup>1</sup>

Ex-Student, School of Physiotherapy, D.Y.Patil University, Navi Mumbai, India<sup>2</sup>

Ex-Director, School of Physiotherapy, D.Y.Patil University, Navi Mumbai, India<sup>3</sup>

**ABSTRACT:** Axial structure plays an important role in many functional activities. Functional axial rotation is a measure of unrestricted trunk rotation in seated position which is required for functional activities of daily living. Stroke, one of the leading causes of disability, affects trunk along with extremities. The purpose of the study was to assess functional axial rotation in stroke patients which had not been documented earlier. Functional axial rotation device was constructed by suspending the hoop from two adjustable tripods. Functional axial rotation device showed excellent test-retest and Inter rater reliability. Functional axial rotation ranges were significantly reduced on paretic side of the stroke patients and ranges showed significant co relation with PASS (change in posture component) and time since onset of stroke.

**KEYWORDS:** Functional axial rotation, trunk ,sitting ,stroke

## **I. INTRODUCTION**

Stroke is one of the leading causes of disability in India. Asians especially Indians have a higher prevalence of stroke. Stroke or Cerebrovascular accident (CVA) is a sudden loss of neurological functions caused by an interruption of blood flow to the brain. A variety of focal deficits are possible, out of which motor deficit are characterized by paralysis (hemiplegia) or weakness (hemiparesis) typically on one side of body, opposite to the side of lesion. It has been documented that stroke may cause marked deficits in extremities, but trunk also gets affected. Since human beings assumed upright stance, upper extremities became free to perform various activities of daily living. The upper extremities are attached proximally to the trunk which plays a major role in stability as well as mobility. The trunk needs to hold against the gravity as well as move along with the upper extremities to provide different combinations of functional movements.<sup>1</sup>

Trunk control has also been identified as an important early predictor of functional outcome after stroke.<sup>2,3,4</sup> It is the ability of the trunk muscles to allow the body to remain upright, and perform selective movements of the trunk so as to maintain the centre of mass within the base of support during static and dynamic postural adjustments Normal trunk range of motion is a prerequisite for trunk control. Axial structure forms the supportive base from which movements of limbs and head occur to perform activities of daily living. Neck and back motion used during many daily functional activities require rotation of the trunk. The activities that incorporate trunk rotation are rolling, coming up to sitting and reaching activities.

It is important to measure functional movement required to accomplish a task rather than just flexion, extension and rotation of the spine. Functional axial rotation is a device which quantifies the type of motion of spine used during functional activities .It is a measure of unrestricted cervico- thoraco-lumbar rotation in seated position. It is portable and easy to construct.<sup>7</sup> The purpose of this study was to quantify functional trunk rotation movement by using functional axial rotation device in patients with stroke,compare with healthy subjects and co relate functional axial rotation ranges with PASS (Postural assessment scale for stroke patients)scores-change in posture component.

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## II. RELATED WORK

Axial structure plays an important role in many functional activities yet very few physical performance measures are available in stroke that capture information related to motion of axial segment.<sup>6</sup> Trunk performance after stroke is evaluated in various ways. Methodological approaches used in previous studies included isokinetic muscle testing, manual dynamometry, Electromyographic and movement analysis. These approaches need to use expensive equipments to assess trunk performance. Functional axial rotation device provides functional dynamic information of spine by combined joint motions of entire spinal column which is essential during functional tasks like when one needs to look behind. It can also have effect on functional tasks like rolling, supine to sit, 360 degree turn.<sup>7</sup> The relationship between functional axial mobility and physical performance was explored in terms of 360<sup>0</sup> turn, functional reach in normal population.<sup>10</sup> However functional axial mobility was not explored in stroke patients.

Review of literature suggests trunk deficit exists in stroke. e.g. Patricia. Davies described 'loss of selective trunk control' as the major functional deficit of post-stroke patients.<sup>1</sup> A cross sectional study by Verheyden et.al demonstrated that trunk control is related to measure of balance, gait, and functional ability in patient with stroke.<sup>5</sup> Trunk rotation has also been given importance in the trunk impairment scales.<sup>17</sup> Many research studies have been done using Functional Axial Rotation device in Parkinson's disease, but its use in stroke is not documented.<sup>8,9</sup>

## III. METHODOLOGY

23 subjects diagnosed with stroke who could sit unsupported and were able to understand and follow simple verbal instruction, (scoring at least 24 on Mini Mental Scale) participated in the study. Their informed consent was taken. Subjects with any known vestibular disorders, musculoskeletal disorders of the neck or trunk affecting the motor performance or visual defects were excluded from the study.

The subjects were then evaluated for the functional axial rotation which is a measure of unrestricted cervical-thoracic-lumbar rotation in seated position, 20 Age matched asymptomatic individuals and 23 stroke patients were made to sit on stool straight as much as possible, feet touching ground, the measuring hoop marked at 5 degrees interval, suspended from two adjustable tripods, was placed around the seated subject. The height of hoop was adjusted to eye level. To ensure that hoop has the same orientation from trail to trail, the front of the hoop (0) marked by a vertical line was aligned with the midline of subject face, and the back of the hoop (180) was aligned with the seventh cervical vertebra. The hoop was moved in anterior/posterior direction until, two lines at 90 and 270 degrees, respectively, were positioned in line with the greater trochanters. To ensure that the rotation motion was accomplished without lifting the pelvis, the subject's pelvis was secured to the chair seat using two straps crossed to form a figure of eight. The cervical goniometer with pointer was fitted over subject's head with the pointer oriented towards the hoop.

Subjects were instructed to let their hands hang loosely by their sides and to turn to the left or right as possible and read the farthest symbol that they could see. Subjects were also instructed to move the neck and torso as much as they could but refrain from gripping the chair seat with their hands. Subjects were not restricted with respect to the motion of their torso.

Data were obtained for rotation (FAR- P) and for report of symbols (FAR - V) to both the left and to the right. Three trials were performed for each side, alternating from right to left side between trials. The first trial in each direction was a practice trial; the second and third trials to each side were test trials. Measurements of FAR- P were taken on 2 different days. On the second day of testing, FAR- P was measured by two raters.

We chose the PASS scale to assess functional independence in stroke patients. This scale consists of 12 items of graded difficulty based on maintaining a posture and changing posture. We have taken only changing posture component which has 7 items. Scoring of the PASS consists of a 4-point scale where items are scored from 0 - 3. The total score ranges from 0-21.<sup>18</sup>

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## IV. RESULTS

1.The following table shows demographic characteristics of stroke patients and control group.

**Table 1:Demographic characteristics**

Demographics	Stroke patient	Control
Number of subject	23	20
Age, years ( mean± sd)	54.21 ±11	52.56(yrs) ±11.28
Gender(M/F)	15/8	12/8
Duration of stroke, months( mean± sd)	9.15 ±4.4	-
Side of hemiparesis(R/L)	14/9	-

We selected gender and age matched individuals for the control group.( $p < 0.001$ )

### 2.Reliability-

Reliability of FAR- P and FAR - V was excellent. Test-retest reliability of FAR- P was excellent (ICC values of .97 & .94 of right & left respectively), FAR - V (ICC values of .97 on both sides). Inter rater reliability likewise was excellent, with ICC values of .97 to the right and equivalent to the left.

**Table 2: Functional axial rotation FAR –P Values in stroke and control group**

Functional Axial Rotation	MEAN OF FAR- P	SD	SEM	95% Confidence interval	
Stroke Paretic side	109.28	16.3	3.408	102.24	116.37
Stroke Non paretic side	132.61	16.59	3.459	125.44	139.78
Control Right	135.76	15.7	3.511	128.41	143.11
Control Left	135.98	16.6	3.5	127.72	141.12

Using ANOVA test for data analysis, it is observed that FAR- P values are affected on paretic side. The difference is statistically significant ( $P < 0.001$ ) between paretic side( $109.28 \pm 16.3$ ) and non paretic side

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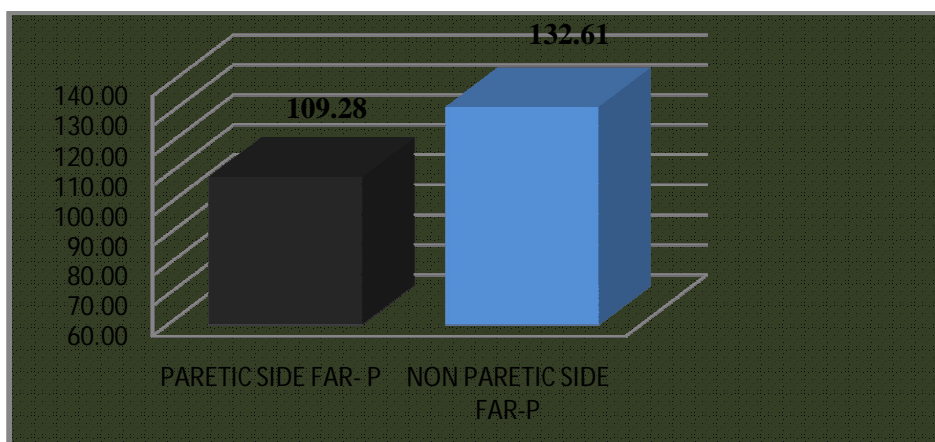
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rotations( $132.61 \pm 16.59$ ). However there was no statistically significant difference ( $P > 0.05$ ) between non paretic side rotation( $132.61 \pm 16.59$ ) and rotations in control group( $135.76 \pm 15.7$ )

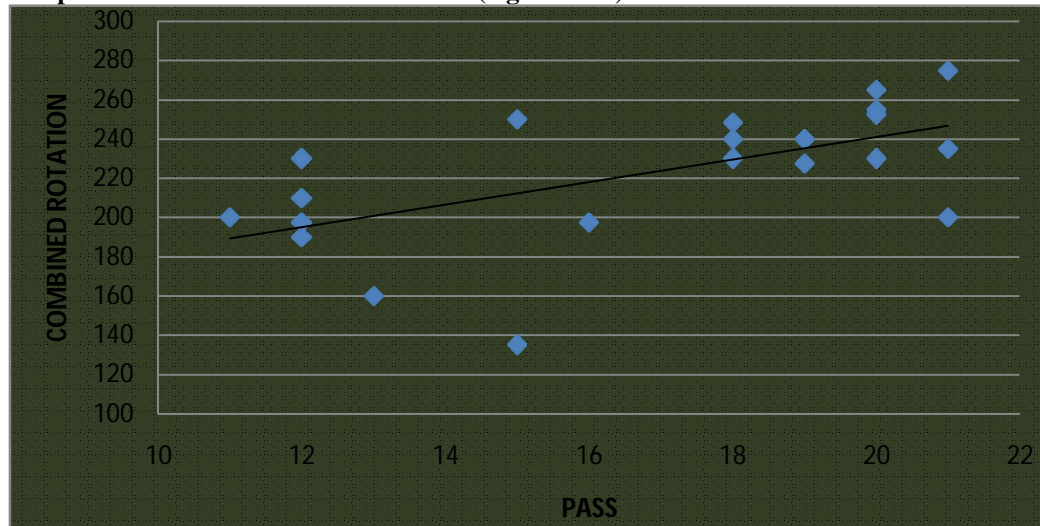
Using unpaired t test of data analysis, it was found that FAR-visual values in stroke patients ( $158.36 \pm 22.4$ ) were affected when compared with subjects in control Group( $173.5 \pm 18.4$ ) significantly with p value of 0.0306

**Graph 1. Functional Axial Rotation –(Physical) range of motion on paretic and non paretic side.**



The graph shows comparison between FAR-P values on paretic side and non paretic side in stroke patients

**Graph 2. Correlation between combined (right & left) Functional Axial Rotation and PASS**



Using the Spearman Correlation, it is observed that, significant correlation exist between the combined rotational ranges (obtained by addition of right and left side FAR- P values) and PASS scores in stroke patients, with p value of 0.0006 and correlation coefficient of  $r=0.6631$

FAR- P values were correlated with time since onset of stroke in months. Using the Pearson correlation statistical test, it is observed that, significant correlation exist with p value of 0.0093 and correlation coefficient of  $r=0.52$

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## V. DISCUSSION

Stroke leads to neuromuscular impairments that include paresis, abnormal muscle tone (spasticity), abnormal coordination and an inability to activate muscles in isolation. Functional axial rotation can be affected due to affection of trunk position sense<sup>11</sup> and strength of muscles.<sup>12</sup> Neuromuscular impairments that restrict motion are likely to lead to the development of a variety of musculoskeletal impairments including muscle tightness, altered patterns of recruitment of motor units, imbalances in muscle activity, changes in muscle fiber type, changes in alignment also contribute to reduced ranges. Previous studies indicated trunk affection in stroke<sup>14</sup>. Isokinetic testing of the trunk rotatory muscle strength was smaller in chronic hemiplegic patients than that of controls<sup>13</sup>, trunk lateral flexor muscle weakness of the paretic side was more compared to non-paretic side<sup>15</sup>

FAR- P values could also be affected due to loss of Counter rotation between the upper and lower trunk. The rotation of the trunk muscle activity is not unilateral, but requires static holding of contra-lateral muscles to stabilize the central aponeurosis, so allowing the antagonist shorten and draws one side of the pelvic or thorax forwards which is affected in stroke patients. In addition, the trunk rotators cannot function efficiently when their origin and insertion are approximated, as flexed spine is the common posture acquired by stroke patients. One of the study on healthy adults concluded that the position and posture of the spine in the sagittal plane appears to have a significant influence on ranges of trunk rotation. It stated that rotating the trunk whilst the thoracolumbar spine is flexed leads to a reduction in trunk rotation range of motion.<sup>16</sup>

.Earlier kinetic and kinematic evidence suggests that trunk is affected bilaterally. The ability to rotate functionally on non affected side was found to be intact in our study as we evaluated the total axial rotation and not a specific deficit. Rotation on paretic side was more affected in left hemiparesis compared to right hemiparesis which can be attributed to right hemisphere, a centre for postural control network. However sample in the present study was limited. Evidence regarding the role of right and left hemisphere in stroke outcome is conflicting and needs further exploration. FAR- P values showed significant correlation with PASS scores. The combined spinal motion set of variables correlated with the physical performance set, indicating a relationship between overall ability for combined spinal motion. The axial spine functions as a unit; thus, regional losses alone may not correlate with performance deficits as strongly as the whole unit<sup>10</sup>

Physical activities are performed by integrating mobility across many regions and planes of spinal motion. Thus Functional axial rotation is a method for assessing a person's ability to perform trunk rotation for accomplishing a function. This measure does not assess the actual spinal range of motion but still gives an estimate of functional deficit. Even if the stroke patients had deficit in trunk rotation control whether they could use it functionally was evaluated in the present study. This device was easy to construct and portable. FAR-P and FAR-V could measure different parameters. Physical parameter indicated the functional range and visual parameter indicated whether they could locate the object behind. This tool can be used to diagnose the functional deficit in trunk rotation as well as to assess the effect of subsequent treatment strategies to improve the functional range. The use of the device can also be extended to other patient population.

## VI. CONCLUSION

Functional axial rotation device is a reliable and useful tool to assess functional axial rotation range in stroke patients. We found that it had high test-retest and Inter rater reliability in stroke patients. Functional axial rotation ranges (physical and visual) were significantly reduced on paretic side. Patients with Right hemiparesis (left hemisphere lesion) showed better ranges than patients with left hemiparesis. But it needs further exploration with a larger sample size. Functional axial rotation physical ranges showed significant correlation with change in posture component of PASS and time since onset of stroke.

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