# Correlation between Weight Transfer on Paretic Limb While Standing in Three Directions and Fugl-Meyer Assessment for Lower Extremities in Individuals with Stroke

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***Objective:*** *To determine the correlation between percent weight transfer on paretic limb while standing and the Fugl-Meyer lower extremity motor assessment scale (FMA_LE) in individuals after stroke.*

***Material and Method:*** *Individuals after stroke who had limited community ambulation and walking speed less than 0.8 m/s were included in the study. Lower extremity motor control was measured in all participants by the FMA_LE and weight transfer on paretic limb while standing on bathroom scales in three directions (lateral, forward and backward). The percent weight transfer on the paretic limb (%WTpar) was the maximum of weight transfer in each direction divided by total body weight. Pearson's correlation coefficient was used for statistical analysis.*

***Results:*** *Forty-four individuals after stroke aged 61.27±12.09 years volunteered to participate in the present study. Their walking speed and FMA_LE were 0.37±0.21 m/s and 18.95±4.11 scores. The %WTpar scores while standing in each direction were 64.15±13.30% for lateral, 58.20±13.35% for forward and 61.10±10.52% for backward. A significant correlation was found between %WTpar in backward direction and FMA_LE (r = 0.38, p = 0.001).*

***Conclusion:*** *The weight transfer on the paretic leg in backward direction could be used as a clinical assessment tool to identify lower extremity performance in individuals after stroke. To minimize the gap of the ordinal scale in FMA_LE, assessment with metric units should be added. Weight transfer assessment while standing on bathroom scales in different directions provided continuous data and should be added to determine lower extremity motor assessment in individuals after stroke.*

***Keywords:*** *Fugl-Meyer assessment, Weight transfer ability, Walking speed, Stroke*

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Stroke is one of the leading causes of chronic disability and death in people who live in developed countries[1-3]. Independent walking is an optimal goal in individuals after stroke[4,5]. Many studies have measured walking ability after stroke by gait velocity[4,6-10]. Perry et al determined the correlation between gait velocity (m/s) and self-ambulated ability measured by the Functional Ambulation Classification (FAC) in individuals after stroke[8]. They classified the gait velocity for ambulatory status in three groups: less than 0.4 m/s for household ambulation,0.4-0.8 m/s for limited community ambulation, and greater than 0.8 m/s for community ambulation[8].

Individuals with chronic stroke having ambulatory limitation encountered difficulty in weight transfer[13]. Although they received weight transfer training in rehabilitation program they stand or walk with asymmetrical weight bearing. They encountered difficulty when bearing weight on the paretic leg and could not transfer weight from one leg to the other[11-13]. Godie and colleagues found that the weight transfer on the paretic leg was less than the non-paretic leg in all directions (65.5% for lateral and 54.9% for backward)[14]. They suggested that weight transfer on the paretic leg in different directions could indicate walking and balance performance in individuals after stroke.

The Fugl-Meyer Assessment is a clinical outcome measure for lower extremity motor control in

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individuals after stroke. The Fugl-Meyer Assessment for lower extremity (FMA_LE) correlated with walking speed and balance performance. Standing balance performance could be simply tested by one leg standing or weight bearing on the paretic leg[15]. A common assessment of weight bearing on the paretic leg was performed in all directions such as lateral and forward but not backward. However, weight transferred on the paretic leg in the step standing position, i.e. forward and backward, was necessary for walking ability in individuals after stroke. Therefore, the present study aimed to investigate the correlation between weight transfer ability while standing on the paretic limb and the FMA_LE score in individuals after stroke who had limited community ambulation.

## Material and Method

Individuals with first stroke who registered at the Physical Therapy Center of the Faculty of Physical Therapy, Mahidol University were recruited in the present study. The inclusion criteria included 1) muscle tone $\leq$2 measured by the Modified Ashworth Scale (MAS), 2) able to follow simple instructions, 3) able to maintain a standing position without any assistance or use an assisting device at least 5 seconds, and 4) walking speed $\leq$0.8 m/s. The exclusion criteria comprised 1) serious visual impairment unable to be corrected by glasses, 2) other serious complicated medical histories, 3) unstable vital signs, 4) dizziness or vertigo, and 5) pain or limitation of the lower extremity range of motion. The present study was approved by the Mahidol University Institutional Review Board (MU-IRB COA.No.2014/005.1301).

Baseline characteristics including age, weight, height, type and time since stroke were recorded. Walking speed was measured by the 10 meters walk test (10 mWT) was performed to obtain gait velocity. The FMA_LE and weight transfer ability while standing were randomly assigned. Lower extremity motor impairment of all participants was measured by the Fugl-Meyer motor assessment where the maximum motor score is 34. The assessment of weight transfer ability while standing was measured by digital bathroom scale (TANITA BC-587 200-kg High Capacity Body Composition Monitor, Tokyo, Japan). The digital bathroom scale was calibrated by putting a 500 grams pendulum (2 pieces) on each digital bathroom scale. All participants stood with two feet apart on two digital bathroom scales separately for each foot. They were instructed to transfer their weight to the paretic leg in three standing positions: 1) stride standing, 2) step standing with affected leg forward, and 3) step standing with affected leg backward. Each position was performed in three trials and the weight was recorded to the fifth second. The maximum weight was recorded.

### *Statistical analysis*

SPSS package version 18 was used for data analysis. Demographic characteristics were analyzed using descriptive statistics, i.e. mean, standard deviation and percentage. Normal distribution was examined by the Kolmogorov-Smirnov goodness of fit test. Pearson's correlation coefficient was used to identify the correlation between the score of FMA_LE and percent weight transfer on the paretic leg (%WTpar). The correlation was interpreted according to Portney and Watkins[16] as follows: 1) poor correlation (0.00 $\leq$r $\leq$0.25), 2) fair correlation (0.25 $\leq$r $\leq$0.50), 3) moderate to good correlation (0.50 $\leq$ r $\leq$0.75), and 4) good to excellent correlation (r$\geq$0.75).

## Results

Forty-four individuals after stroke volunteered to participate in the present study. Baseline characteristics and %WTpar in all directions are presented in Table 1. The mean scores of the 10mWT and the FMA_LE were 0.37$\pm$0.21 m/s and 18.95$\pm$4.11, respectively. A significant correlation was found between FMA_LE and %WTpar in the backward direction (r = 0.38, $p$ = 0.011) (Table 2).

## Discussion

The results demonstrated a fair correlation of FMA_LE and %WTpar only in the backward direction in individual who had limited ambulation. Yang et al[17] suggested that backward walking training could improve walking abilities in patients after stroke. They received additional backward walking training for 30 minutes within parallel bars three times a week over three weeks. The results showed that individuals after stroke had improvements of gait velocity, cadence, stride length, symmetry index and gait cycle. Moreover, changed scores between pre- and post- training exhibited significant improvements of gait velocity, stride length and symmetry index. Likewise, a study by Marden Lokken et al[18] found increased ability in the 6-minute walk distance (6MWD), and stride length and a decrease in the 10mWT at posttest. At 2 months after retention the 6MWD increased by 23% and slight improvements were observed in the 10mWT, stride length and step length from posttest after participants with stroke walked backward on a treadmill for 30

**Table 1.** Baseline characteristics and percent weight distribution in all directions of 44 participants after stroke

| Baseline characteristics | Mean $\pm$ SD or n (%) |
|---|---|
| Age (years) | 61.27$\pm$12.09 |
| Weight (kilogram) | 66.55$\pm$15.12 |
| Height (centimeter) | 163.55$\pm$8.30 |
| BMI (kilogram/meter$^2$) | 24.70$\pm$4.47 |
| Time since stroke (month) | 50.59$\pm$60.39 |
| 10mWT (meter/second) | 0.37$\pm$0.21 |
| Lower extremity score of Fugl-Meyer assessment | 18.95$\pm$4.11 |
| Lateral direction of paretic leg in standing position | 64.15$\pm$13.32 |
| Forward direction of paretic leg in step stance posture | 58.20$\pm$13.35 |
| Backward direction of paretic leg in step stance posture | 61.01$\pm$10.52 |
| Sex, (n, %) | |
| Male | 27 (61.4) |
| Female | 17 (38.6) |
| Type of stroke (n, %) | |
| Hemorrhage | 18 (40.9) |
| Infarction | 24 (54.5) |
| Embolism | 2 (4.5) |
| Hemiparesis side (n, %) | |
| Left | 20 (45.5) |
| Right | 24 (54.4) |

**Table 2.** The correlation between lower extremity score of Fugl-Meyer assessment and percent weight distribution on the paretic limb

| Percent weight distribution | Lower extremity score of Fugl-Meyer assessment | |
|---|---|---|
| | Correlation coefficient (r) | *p*-value |
| Lateral direction | 0.260 | 0.180 |
| Forward direction | 0.256 | 0.093 |
| Backward direction | 0.380* | 0.011* |

* *p*-value <0.05

minutes, three times a week.

The present study reported average weight transfer on the paretic leg in the lateral direction was 64.15% of body weight and forward direction was 58.20%. Similarly, Goldie et al[14] studied the ability to transfer body weight onto the affected and unaffected legs in lateral and forward directions in individuals after stroke. They found that weight transfer on the affected leg in the lateral direction was 65.5% of body weight and forward direction was 54.9% of body weight. Therefore, individuals after stroke had weight transfer on the paretic limb in the lateral direction more than other directions especially in forward and backward directions, which might be caused by the limit of stability. In addition, this study showed walking speed was fairly correlated with percent weight transfer on the paretic leg that could indicate walking performance in individuals after stroke as Mercer et al[19] reported weight transfer ability was an important indicator for the impairment and functional activities levels.

## Conclusion

The change of walking ability from dependent to independent should be measured by specific assessment. The weight transfer on the paretic leg in the backward direction was suggested as the clinical assessment tool to indicate lower extremity performance in individuals after stroke. The information will be useful for planning effective treatment programs and also for training walking performance in individuals after stroke. To minimize the gap of the ordinal scale in FMA_LE, assessment with metric units should be added. Weight transfer assessment while standing on bathroom scales in different directions provided continuous outcomes and should be added to determining lower extremity motor assessment in individuals after stroke.

## What is already known on this topic?

The Fugl-Meyer assessment is used as a clinical assessment for motor impairment and to predict walking performance[11]. In addition, the functional ambulation recovery in individuals after stroke could be monitored by percent of weight transfer asymmetrically between both legs.

## What this study adds?

The ability of the weight transfer tests on the paretic limb in lateral, forward and backward directions, while standing, in individuals with stroke with walking speed $\leq$0.8 m/s were reported in this present study. The correlation of FMA_LE and %WT on the paretic leg was demonstrated.

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**Potential conflicts of interest**

None.

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# ความสัมพันธ์ระหว่างความสามารถในการลงน้ำหนักบนขาข้างอ่อนแรงขณะยืนและคะแนน Fugl-Meyer ของรยางค์ส่วนล่างในผู้เป็นโรคหลอดเลือดสมอง

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***วัตถุประสงค์:*** *เพื่อศึกษาความสัมพันธ์ระหว่างค่าร้อยละการถ่ายน้ำหนักบนขาข้างอ่อนแรงในขณะยืนและคะแนน Fugl-Meyer ของรยางค์ส่วนล่างในผู้ป่วยโรคหลอดเลือดสมอง*

***วัสดุและวิธีการ:*** *ผู้ป่วยโรคหลอดเลือดสมองที่เข้าร่วมการศึกษาครั้งนี้เป็นผู้ป่วยที่มีข้อจำกัดในการใช้ชีวิตในสังคมและมีความเร็วในการเดินช้ากว่า 0.8 เมตร/วินาที ประเมินความสามารถของรยางค์ส่วนล่าง ด้วยคะแนน Fugl-Meyer และค่าร้อยละการถ่ายน้ำหนักของขาข้างอ่อนแรงขณะยืนบนเครื่องชั่งน้ำหนักระบบดิจิทัลใน 3 ทิศทาง (ด้านข้าง, ด้านหน้า, และด้านหลัง) ค่าร้อยละการถ่ายน้ำหนักไปบนขาข้างอ่อนแรงคือ ค่าสูงสุดของการถ่ายน้ำหนัก ในแต่ละทิศทางของน้ำหนักรวมทั้งหมดของร่างกาย การวิเคราะห์ทางสถิติใช้ ค่าสัมประสิทธิ์สหสัมพันธ์เพียร์สัน*

***ผลการศึกษา:*** *ผู้ป่วยโรคหลอดเลือดสมอง 44 ราย ซึ่งมีอายุ 61.27±12.09 ปี อาสาสมัครเข้าร่วมในการศึกษานี้ ความเร็วในการเดินและคะแนน Fugl-Meyer ของรยางค์ขาคือ 0.37±0.21 เมตร/วินาที และ 18.95±4.11 คะแนน ค่าเฉลี่ยการถ่ายน้ำหนักบนขาข้างอ่อนแรงในขณะยืนในแต่ละทิศทางคือทิศด้านข้างมีค่า 64.15±13.30%, ด้านหน้ามีค่า 58.20±13.35%, และด้านหลังมีค่า 61.10±10.52% มีค่าความสัมพันธ์อย่างมีนัยสำคัญทางสถิติระหว่าง ค่าร้อยละของน้ำหนักตัวที่กระจายไปบนขาข้างอ่อนแรงในทิศด้านหลังและคะแนน Fugl-Meyer ของรยางค์ขา (r = 0.38, p = 0.01)*

***สรุป:*** *การถ่ายน้ำหนักไปบนขาข้างอ่อนแรงในทิศทางด้านหลังสามารถใช้เป็นเครื่องมือในการประเมินในทางคลินิก เพื่อบ่งชี้ถึงความสามารถในการทำงานของขาในผู้ป่วยโรคหลอดเลือดสมองและเพื่อลดช่องว่างของสเกลแบบลำดับจาก Fugl-Meyer ของรยางค์ขาจึงควรใช้ร่วมกับวิธีประเมินที่มีหน่วยเมตริก การประเมินการยืนถ่ายน้ำหนักบนเครื่องชั่งในทิศทางต่าง ๆ ให้ค่าข้อมูลแบบต่อเนื่อง วิธีนี้ควรนำมาใช้ร่วมเพื่อประเมินความสามารถของรยางค์ขาในผู้ป่วยโรคหลอดเลือดสมอง*