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Original Article

The relationship between anterior pelvic tilt and gait, balance in patient with chronic stroke

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Abstract. [Purpose] The aim of this study is to find out the association between anterior pelvic tilt and gait and balance in chronic stroke. [Subjects and Methods] Fourteen chronic stroke patients were included in this study. A palpation meter was employed to measure the anterior inclination of the pelvis. A GAITRite system automates measuring temporal and spatial gait parameters. A 10-Meter Walk test was used to measure gait speed. The Timed Up and Go test was used to measure the dynamic balance ability and gait ability of the participants. A BioRescue was used to assess balance by measuring the moving distance and area of the center of pressure. [Results] There were significant negative correlations between pelvic anterior tilt and velocity, step length, and stride. There were significant positive correlations between velocity and cadence, step length, and stride length. There were significant negative correlations between velocity and cycle time, H-H base, TUG, and 10MWT. There was significant negative correlation between cadence and cycle time and H-H base. [Conclusion] This study showed a negative correlation between pelvic anterior tilt and gait function including gait speed and step length.
Key words: Anterior pelvic tilt, Chronic stroke, Gait

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INTRODUCTION

Stroke patients have disabilities that result from paralysis, and most complain of difficulty walking[1]. Altered pelvic alignment and asymmetrical weight bearing onto lower limbs are common[2], resulting from poor trunk-pelvis dissociation or reduced hip muscular control[3]. Abnormal pelvic motion including pelvic anterior tilt occurs in stroke patients[4], and abnormal pelvic tilt is related to trunk control, balance, and gait function after stroke[5–9]. However, there was no study that confirmed the effects of anterior pelvic tilt in patients with stroke. Therefore, the aim of the present study is to determine the association among anterior pelvic tilt, gait, and balance in patient with chronic stroke.

SUBJECTS AND METHODS

Fourteen chronic stroke patients (from D Welfare Center, Korea) were included in this study. Prior to the start of the study, all subjects understood the study protocol and signed an informed consent form. The ethical committee of Daegu University approved this study (IRB: 1040621-201611-HR-020-02). This study complied with the ethical standards of the Declaration of Helsinki.

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Table 1. Correlation and significance between PALM and gait variables

	Mean ± SD	PALM	
		Correlation (r)	Significance (p)
Velocity (cm/s)	63.69 ± 21.71	−0.61	0.03*
Cadence (steps/min)	95.36 ± 16.69	−0.38	0.22
Step length (cm)	39.48 ± 8.69	−0.59	0.04*
Stride length (cm)	79.57 ± 17.34	−0.60	0.03*
Cycle time	1.29 ± 0.22	0.41	0.18
H-H base	13.76 ± 3.61	0.49	0.10
TUG	14.78 ± 3.95	0.52	0.08
10MWT	13.06 ± 3.84	0.49	0.10
LOS	2,196.29 ± 2,078.22	−0.03	0.92
Sway length (EO)	41.63 ± 18.75	0.40	0.18
Sway velocity (EO)	0.69 ± 0.33	0.36	0.23

PALM: anterior pelvic tilt angle, *p<0.05.

Patients were required to meet the following criteria for inclusion: 1) chronic stroke involving cerebral regions (over six months post-stroke) with an anterior pelvic inclination (>15°, normal range 11 ± 4°)[10, 11], 2) Brunnstrom stage of motor recovery for the affected lower limb range of 3–5, 3) ambulatory but with residual gait deficit as defined as a visual gait abnormality assessed by a licensed physical therapist (including those who use a cane or walker), 4) ability to understand and follow simple verbal instructions, 5) independent gait ability to walk at least 15 m without assistance, 6) no disability in visual, auditory, and vestibular organs, 7) no history of orthopedic diseases, such as contracture, fracture, or arthritis in lower limbs, and 8) a Mini-Mental State Examination score greater than 24/30[12].

Exclusion criteria were as follows: 1) neurological problems other than stroke that would interfere with gait and balance control, 2) pain, limited motion, or weakness in the non-paretic lower extremity that affected performance of daily activities (by self-report), and 3) allergy to the Kinesio tape or having a skin disease. General characteristics of subjects were as follows: age (years) 64.29 ± 7.39, height (cm) 163.36 ± 10.40, weight (kg) 61.86 ± 14.98, gender (male/female) 7/7, type (hemorrhagic/ischemic) 4/10, duration (month) 94.50 ± 22.88, anterior pelvic tilt angle 15.43 ± 2.17.

A palpation meter (PALM; Performance Attainment Associates, St. Paul, MN, USA) was employed to measure the anterior inclination of the pelvis. During the measurement, the participants wore non-restrictive clothing, removed their shoes, and spread their feet approximately 10–12 cm. They stood in an upright position, leaning the anterior aspect of the thighs against a stabilizing table[13]. The investigator palpated the prominence of the ipsilateral anterior superior iliac spine (ASIS) and posterior superior iliac spine (PSIS) and marked them with a black pen. The anterior pelvic tilt angle was measured by placement of the caliper tips of the PALM in contact with the ipsilateral ASIS and PSIS[14].

A 10-Meter Walk test (10MWT) was used to measure gait speed. For the 10-m walking test, test-retest reliability is reported at 0.95 and inter-rater reliability at 0.90[15]. Subjects conducted three trials in succession, with a brief seated or standing rest as needed between trials, and the average time was calculated.

A BioRescue (RM Ingenierie, Rodez, France) was used to assess balance by measuring the moving distance and area of the center of pressure[16]. Limits of stability test, which has good test-retest reliability (ICC=0.78–0.91) for patients with stroke[17, 18], measured dynamic postural stability using a BioRescue system. Three trials were performed and the average value calculated.

A GAITRite (GAITRite, CIR Systems Inc., USA) system automates measuring temporal (timing) and spatial (distance) gait parameters (temporal/spatial). Based on normal category values on a histogram, GAITRite can compare gait velocity (meter/sec), gait cycle (cycle/sec), and the symmetry index (%) of the stance phase and the swing phase[19]. To compare the spatiotemporal gait parameters of the subjects among three kinds of experimental conditions, walking velocity, step and stride lengths, and base of support were measured[20]. Subjects performed three trials, and the average calculated.

The Timed Up and Go (TUG) test was used to measure the dynamic balance ability and gait ability of the participants. Each subject completed the TUG test three times with a 30 second break between each trial, and the average calculated.

SPSS (IBM Corp. Released 2014. IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.) was used to analyze the data. Partial correlation coefficients were calculated between anterior tilt angle and gait parameters. In this study, we decided that individual balance ability is confounding factor which could influence gait parameters. To adjust for this, sway length and velocity with eyes closed were used as controlling variables. Null hypotheses of no difference were rejected if p-values were less than 0.05.

RESULTS

There were significant negative correlations between pelvic anterior tilt angle and velocity (r=−0.61), step length (r=−0.59), and stride length (r=−0.60) (Table 1). There were significant positive correlations between velocity and cadence

Table 2. Correlations among gait variables

		Cadence (steps/min)	Step length	Stride length	Cycle time	H-H base	TUG	10MWT	LOS
		95.36 ± 16.69	39.48 ± 8.69	79.57 ± 17.34	1.29 ± 0.22	13.76 ± 3.61	14.78 ± 3.95	13.06 ± 3.84	2,196.29 ± 2,078.22
Velocity (cm/s)	63.68 ± 21.71	0.79**	0.84**	0.85**	−0.78**	−0.84**	−0.82**	−0.78**	0.18
Cadence (steps/min)	95.36 ± 16.69	1.00	0.35	0.36	−0.98**	−0.62*	−0.53	−0.42	0.17
Step length	39.48 ± 8.69		1.00	1.00**	−0.35	−0.75**	−0.81**	−0.83**	0.14
Stride length	79.57 ± 17.34			1.00	−0.36	−0.76**	−0.80**	−0.83**	0.14
Cycle time	1.29 ± 0.22				1.00	0.65*	0.52	0.38	−0.16
H-H base	13.76 ± 3.61					1.00	0.70*	0.68*	−0.07
TUG	14.78 ± 3.95						1.00	0.87**	−0.47
10 MWT	13.06 ± 3.84							1.00	−0.30

Mean ± SD. *p<0.05, **p<0.01

(r=0.79), step length (r=0.84), and stride length (r=0.85). There were significant negative correlations between velocity and cycle time (r=−0.78), H-H base (r=−0.84), TUG (r=−0.82), and 10MWT (r=−0.78) (Table 2). There were significant negative correlations between cadence and cycle time (r=−0.98) and H-H base (r=−0.62) (Table 2).

DISCUSSION

The results of this study showed that as pelvic anterior tilting increased, the velocity, step length, and stride length significantly decreased. More anterior pelvic tilt is associated with balance dysfunction and weight-bearing asymmetry in chronic stroke patients[5, 6]. Since abnormal pelvic tilt is related to trunk control and balance[6, 8, 21], which is important for gait function, it could have effect on velocity, step length, and stride length. In addition, differences in pelvic displacement and gait time and number of steps are associated[21].

In our results, as gait velocity increased, cadence, stride length, and step length significantly increased in chronic stroke patients. As gait velocity decreased, gait cycle time and H-H base support significantly decreased. TUG and 10MWT time significantly increased. These results indicate that decreased gait velocity is related to poor balance function, since increased TUG and 10MWT time and decreased H-H base support and step length mean balance dysfunction. The present study supports research that showed an association between pelvic displacement and poor balance ability[21].

Cadence means number of full cycles taken within a minute, by the pair of feet. As cadence decreased, cycle time significantly increased and H-H base support decreased.

In conclusion, this study showed a negative correlation between pelvic anterior tilt angle and gait function including gait speed and step length.

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