

**OPTIMAL STEPPING STRATEGY IN UPWARD LATERAL SLOPE WALKING**

**Chen-Yu Huang<sup>1</sup>, Chien-Ju Lin<sup>1</sup>, Lin-Hwa Wang<sup>1,2</sup>, and Fong-Chin Su<sup>1</sup>**

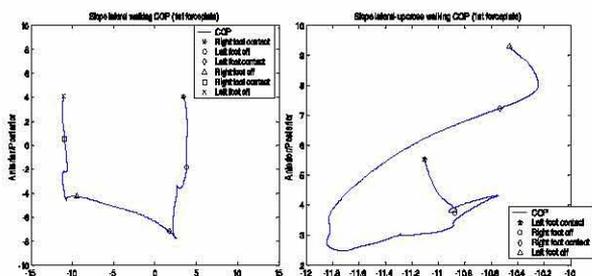
<sup>1</sup>Institute of Biomedical Engineering and <sup>2</sup>Institute of Physical Education, National Cheng Kung University, Tainan, Taiwan

**KEY WORDS:** side step, cross step, lateral slope walking, weight shifting.

**INTRODUCTION:** The slope walking is frequently used while passing through a narrow lane or working on tubular steel scaffolding. Although the gait analysis in slope walking, slope-lateral walking, and step walking etc. have been extensively conducted (Hirosige et al., 2006), the stepping strategy, side step and cross step, has not been investigated. We hypothesized that the cross step is less stable than side step in upward lateral walking on a slope.

**METHOD:** Twelve normal subjects (six males and six females, mean ages: 22.6±2.0 years, height: 167.1±6.3 cm and weight: 60.5±10.0kg) participated in this study. An EVa RT system (Motion Analysis Corporation, Santa Rosa, CA, USA) and two forceplates were used to capture trajectories of markers and ground reaction forces, respectively. The switch sensors were placed on the foot to recognize the steps. Then subject performed upward lateral walking on a 5° slope at least three trials using side step and crossing step, respectively. The center of pressure (COP) was calculated to analyze the weight shifting.

**RESULTS AND DISCUSSION:** Figure1 and Table 1 show the trajectories of COP and its anterior-posterior components, respectively.



**Fig. 1** The trajectories of COP, side step (left) and crossing step (right).

**Table 1** Anterior-posterior COP shift (cm)

	Double stance		1 <sup>st</sup> single stance		2 <sup>nd</sup> single stance	
	side	cross	side	cross	side	cross
Mean	2.03	4.43	1.58	2.15	3.82	7.19
SD	2.01	2.54	1.33	1.19	1.81	1.75
p value	0.001*		0.15		0.001*	

The anterior-posterior COP shift was significantly different in double stance and 2nd single stance ( $p < .001$ ) between side-step and cross-step lateral walking. The trajectory of COP in cross-step walking was less smooth and obvious swayed more than the side-step walking on a slope. Although the difference of anterior-posterior sway is not significant in 1st single phase ( $p = 0.15$ ), the weight shifting was greater in cross step compared to side step. The body swing caused by the rear leg crossing through the leading leg in single stance and the dynamic weight transfer of two cross legs in double stance illustrate the greater anterior-posterior COP shift in cross-step walking.

This is a first study to investigate the effect of stepping strategy on body sway during upward slope walking. Greater COP shift in cross step reveals that cross-step walking is less stable than the side-step walking. For the cross-step lateral walking, the safety issue must be concerned to prevent falls.

**REFERENCES:**

Hirosige, T., Toshihiko, Y., Takahiro, T., Hitoshi, K., Masahiro, K., Hiroshi, O., Kazunari, T., Jun, Y. (2006). Postural Control for Initiation of Lateral Step and Step-up Motions in Young Adults. *Journal of Physical Therapy Science*, 18(1): 49-55.