SPEED RELATED CHANGES IN LOWER LIMB JOINT CONTRIBUTIONS TO MECHANICAL ENERGY DURING GAIT OF STROKE SUBJECTS

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INTRODUCTION

Estimations of the relative contributions for each joint to the total energy involved in gait at different speeds may be central to precisely understanding the nature, extent, and degree of compensation across joints in subjects with locomotor disorders to provide more efficient rehabilitation.

The purpose of this study was to determine the relative contributions of the ankle, knee, and hip joint muscles to the total energy generated and absorbed during gait at natural and maximal speeds with stroke subjects.

METHODS

Fifteen subjects (five women and 10 men), mean age (58.3 ± 13.8 years), walked with their low-heeled shoes (five wore ankle-foot orthoses) without ambulatory aids. They were asked to walk at their natural speed and then, as fast as possible along a 9-meter walkway. Data were obtained with a 3-D Optotrak system and AMTI force platforms. An inverse dynamic approach was used to yield kinetic variables. Work generated and absorbed during gait by flexors and extensors for all joints were summed and the relative contributions to total positive and negative work for both speeds were calculated for each joint. Three within-factor repeated measures ANOVA, followed by contrasts, were used for laterality, joint, and speed effects.

RESULTS AND DISCUSSION

Mean (±1 SD) values for the natural and maximal speeds of 0.70 (± 0.30) m/s and 1.28 (± 0.37) m/s, were similar to those previously reported [1].

Side effects: For the generation contributions, significant differences between sides for both speeds were found only for the ankle and hip joints For absorption, differences were significant for the ankle and knee (Table 1).

The relative contributions of the affected (AS) /non-affected (NAS) sides to the total energy generated at natural speed were 40/60%. Corresponding values for absorbed work were 41/59%. At maximal speed, the respective values were 38/62% and 36/64%, demonstrating, as opposed to healthy subjects [2], the asymmetric nature of hemiparetic gait [1].

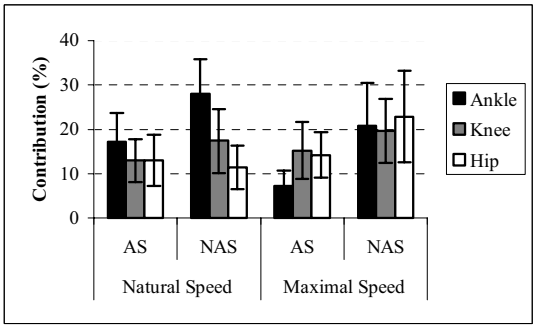

Figure 1: Relative contributions (%) of ankle, knee, and hip to total energy (generation + absorption) across speeds

Joint effects: For AS, contributions at the ankle were different from the other joints at both speeds, whereas for the NAS, all differences across joints were significant only for natural speed.

Speed effects: Supporting previous findings with healthy subjects [2], contributions at the knee and hip increased at maximal speed, while those at the ankle substantially decreased (Figure 1). Increases in generation were higher at the hip, whereas those in absorption were higher at the knee.

CONCLUSIONS

These findings demonstrated the interplay between limbs and joints associated with increases in walking speed. The asymmetry of hemiparetic gait indicates greatest contributions of the NAS side at both speeds. This model easily identifies segments that compensate for others with different task demands. The next step is to apply this model to determine effects of lower limb strengthening programs on these relative contributions for stroke victims.

REFERENCES

[1].Olney SJ et al. Work and power in gait of stroke patients. Arch Phys Med Rehabil 72, 309-314, 1991.

[2].Teixeira-Salmela et al. Lower limb joint contributions to energy generation and absorption during gait: Effects of cadence and laterality. Submitted, 2005.

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Table 1: Contributions (%) to Generation and Absorption of Energy at Ankle, Knee, and Hip for Natural and Maximal Speeds

Joint	Natural Speed				Maximal Speed			
	Generation		Absorption		Generation		Absorption	
	AS	NAS	AS	NAS	AS	NAS	AS	NAS
Ankle	14	27	18	27	12	22	2	20
Knee	10	9	14	22	9	10	23	31
Hip	16	24	9	10	17	30	11	13
Total	**40**	**60**	**41**	**59**	**38**	**62**	**36**	**64**
	100		100		100		100	