

# RESTORATION OF GAIT USING A NEW HYBRID-FES ORTHOSIS (PRIMEWALK) IN A COMPLETE PARAPLEGIC PATIENT

T. Matsunaga, Y. Shimada, K. Sato, A. Misawa, S. Ando, T. Minato,  
M. Sato, K. Hatakeyama, S. Chida, K. Iizuka

Department of Orthopedic Surgery, Akita University School of Medicine

1-1-1 Hondo, Akita, 010-8543, Japan

## ABSTRACT

The purpose of this study was to evaluate the restoration of FES gait using a new medially linked knee ankle foot orthosis (Primewalk) in a paraplegic patient. The walking speeds, the step cadence and the step length at the Primewalk/FES gait were measured and compared with those at the Walkabout/FES gait. All parameters were significantly greater at the Primewalk/FES gait ( $p < 0.05$ ). The sliding mechanisms of the medial hip joint made it possible to improve the ability of gait. The results suggest that the Primewalk is clinically useful for the hybrid- FES gait.

Key words: hybrid-FES, medially linked knee ankle foot orthosis, Primewalk, paraplegia

## INTRODUCTION

Functional electrical stimulation (FES) and orthotics can be combined as a hybrid orthosis to overcome the limitations of either approach when used alone. “Walkabout” is one of several medially linked knee ankle foot orthosis (MLKAFO) [1]. The Walkabout can be used as a hybrid-FES orthosis to restore ambulatory function in paraplegic patients. The step length of the Walkabout/FES gait is restricted because the medial joint is placed under the hip, and accordingly the walking speed becomes slow. During the Walkabout/FES gait, the paraplegic patient sometimes rotated their pelvis to gain a longer step length. Therefore, further improvement is needed for the MLKAFO’s FES gait. Recently, a new MLKAFO named “Primewalk” was developed by Saitoh and colleagues [2]. The purpose of this study was to compare the Walkabout/FES gait and the Primewalk/FES gait.

## METHODS

*Subject* A 30-year-old man with T8 complete paraplegia volunteered for this study. His informed consent was obtained. He had already started an FES program for his lower limbs using implanted parcutaneous intramuscular electrodes. The time since injury was 5 years and the follow-up time since starting the FES program was 4 years. He was previously able to perform standing-up, standing, and sitting-down using only FES. He was also able to walk

using both FES and ankle-foot orthosis.

*The FES system* We developed a stimulator having 2 hand switches for both right and left legs (AKITA STIMULATOR II). The rectangular pulse trains that were used consisted of a pulse with of 0.2 msec, a pulse interval of 50 msec, and an output voltage modulated from 0 to -15V. When the patient pressed the hand switch, the hip flexors and the contra-lateral hip extensors were electrically stimulated simultaneously. The iliopsoas muscle and the femoral nerve were stimulated for the hip flexion. The gluteus maximus and long head of the biceps femoris were stimulated for the hip extension. Reciprocal gait was obtained by the repetition of switch-on and switch-off with the 2 hand switches.

*The hybrid-FES gait analysis* The walking speeds, the step cadence and the step length during the FES assisted gait of the subject, wearing Walkabout and Primewalk, were measured. The L-walker was used to support the gait.

## RESULTS

The walking speeds were  $5.23 \pm 0.97$  m/min (Mean  $\pm$  SD) at Walkabout/FES gait and  $9.27 \pm 0.65$  m/min at Primewalk/FES gait. The step cadences were  $24 \pm 2$  steps/min at Walkabout/FES gait and  $27 \pm 1$  steps at Primewalk/FES gait. The step lengths were  $0.22 \pm 0.03$  m at Walkabout/FES gait and  $0.43 \pm 0.07$  m at Primewalk/FES gait. All parameters were significantly greater at Primewalk/FES gait than at Walkabout/FES gait ( $p < 0.05$ ).

## DISCUSSION

The medial hip joint of the Primewalk is positioned under the hip in the same way as the Walkabout. However, the physiological axis of the Primewalk is higher than that of the Walkabout. This is due to the sliding mechanisms of the Primewalk system [2]. The two mechanisms of the hip joint are quite different between the Primewalk and Walkabout. During Primewalk/FES walking, the patients can swing their legs more easily and walking speeds, step cadence and step length are improved. Future studies could include: the stability of the Primewalk/FES gait and the energy cost of using the Primewalk system.

## REFERENCES

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