Comparisons of the swing through gait motion with and without the short leg brace

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Abstract

<OBJECTIVE> Swing through gait is mostly adopted to help locomotion for paraplegics. This gait pattern shows faster and lower energy consumption than a reciprocal gait for paraplegics. The purpose of this study was to investigate kinematics data during swing through gait motion due to produce a functional electrical stimulation pattern.<SUBJECTS AND METHODS> Thirty-nine normal male subjects participated in this study. We measured the gait parameters during swing through gait with and without the short leg brace. The gait velocity, hip, knee, ankle joint angle, the joint moment, and the energy expenditure of the pectoralis major muscle were calculated using the PEAK motion analysis system and the Kistler Force Plate. <RESULTS> No statistical differences were observed between in the gait velocity and the cadence with and without the short leg brace. A hip flexion angle, knee extension moment, and energy expenditure of the pectoralis major muscle with the short leg brace was greater than without the brace. <CONCLUSION> The results showed that the short leg brace can make a contribution to ankle joint stability, clearance in swing phase, and knee extension moment. It is necessary to stimulate a hip joint flexor muscle during swing through gait.

1 Introduction

The reconstruction of walking in paraplegic patients is physiologically, psychologically, and functionally beneficial. Physiological benefits include the improvement of blood circulation and the prevention of osteoporosis; psychological benefits include the benefit of being able to establish eye contact in conversation at the eye level of other people; and functional benefits include an improvement in mobility. We have been restoring paraplegic gait with Functional Electrical Stimulation (FES) since 1990 [1]. Paraplegic gait has high energy cost, so we have used several types of hybrid FES with FRO, AKJ, RGO and the Walkabout to prevent muscle fatigue, reduce energy consumption, and enable better stability in the lower extremities [2]. However, it is apparent that the reciprocal gait indicates slow velocity and high energy consumption in paraplegics due to the weight shift between the lower extremities, using upper extremities. Therefore, paraplegics utilized wheelchairs to move.

Several authors reported swing through gait is mostly adopted to help locomotion for paraplegics [3]. In paraplegic patients, this gait pattern shows faster and lower energy consumption than a reciprocal gait. It is the fastest and most effective gait pattern for paralyzed patients who are able to perform it with the use of leg braces and crutches.

The purpose of this study was to investigate kinematics data during swing through gait motion to produce a functional electrical stimulation pattern.

2 Methods

Experiments were performed on thirty-nine normal male subjects. The average age was 27 years, average height 1.73m, and average weight was 66.2kg. They walked using a lofstland crutch for swing through gait pattern with and without the short leg brace. In this type of locomotion, both feet support the body
weight when the crutches are brought forward. We measured kinetic and kinematics data during swing through gait.

The subjects walked at a self-selected speed using swing through gait. Ground reaction forces were monitored on a Kistler 9286 Force Plate. The kinematics data was carried out using a PEAK motion analysis system. The movements of the markers were recorded at a frequency of 60 Hz by six infrared cameras. Each pair of cameras were placed 2.5m above the ground. Fifteen light-reflecting markers were placed on anatomic landmarks bilaterally: on the C7, acromions, the elbows, the trochanter major, the external part of the lateral femoral condyles, the lateral malleoli, the fifth metatarsal heads, and end of the lofstland crutches.

We measured the gait parameter during swing through gait with and without the short leg brace. The angle of the hip, ankle joints, joint moment, and energy consumption of the pectoralis major muscle were measured using the PEAK motion analysis system and the force plate.

3 Results

In the short leg brace, the gait velocity was 42.6 m/min. Without the short leg brace, the gait velocity was 45 m/min. There were no significant differences in the walking velocities and the cadence between with and without the short leg brace. However, the hip joint angle using the short leg brace was 65 deg and without the short leg brace it was 42 deg. There was a significant difference in the hip joint angle between with and without the short leg brace (p< .05) (Fig 1). The pectoralis major muscle using the short leg brace was 9.3 cal/kg/min and without the short leg brace it was 2.9 cal/kg/min. There was a significant difference in the energy consumption of the pectoralis major muscle between with and without the short leg brace (p< .05) The short leg brace provides more knee joint extension moment than without the brace.

4 Discussion and Conclusions

The swing through gait has been adopted by most crutch users in this kind of locomotion.

The subject moves forward by alternating support on both feet and on the crutches. The swing through gait seemed to have many merits: ease, speed and efficiency. In this study, the subject walked at approximately 0.7 m/min with and without the short leg brace. The short leg brace didn’t interfere with gait velocity.

It is clear that basic requirements for achieving ground clearance during locomotion mechanisms, are using hip, knee flexion and ankle dorsiflexion [5]. In this study, the hip flexion angle and pectoralis major muscle activity with the brace is greater than without the brace in normal subjects. Because paraplegic patients couldn’t control the ankle dorsiflexion and lack of somatosensory, it was more difficult to make ground clearance than normal patients. So, paraplegic patients indicate a high hip flexion angle during swing phase. It influences muscle activity of upper extremity. And it produce a high muscle activity of pectoralis major. The FES could control the ankle dorsiflex, however it required stabilization in the standing phase and mobilization in the swing phase at the ankle joint. Therefore, the short leg brace is useful for paraplegic gait. In addition, the short leg brace produce knee extension moment in standing phase. This moment reduced a muscle activity for quadriceps. It could keep muscle fatigue to a minimum.

The results showed that the short leg brace could make a contribution to ankle joint stability, clearance in swing phase and knee extension moment on swing through gait. It is necessary to stimulate a hip joint flexor muscle at swing through gait.
References


