The Development of a Knee Locker with Closed-loop Functional Electrical Stimulation (FES) for Hemiplegia in Gait Training

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摘要

Abstract

PURPOSE: A knee locker with closed-loop functional electrical stimulation (FES) system has been developed to prevent the quadriceps weakness and the drop-foot of the hemiplegia during gait training. METHOD: The FES system is triggered by a footswitch on the heel of the disabled foot to stimulate the tibialis anterior muscle for dorsi-flexion and to turn-off the knee locker in the swing phase through the main controller. Besides, the footswitch on the heel of the affected-side can be used to stimulate the quadriceps and to turn-on the knee locker for quadriceps weakness in the stance phase. RESULTS: It is revealed that the mean velocity, cadence, stride length, active ankle motion range, and functional ambulation category (FAC) have improved significantly from 0.15 +/- 0.04 m sec(- 1), 43.3 +/- 15.4 steps min(- 1), 0.36 +/- 0.11 m, 15 degrees, level 2 to 0.43 +/- 0.21 m sec(- 1), 69.4 +/- 19.1 steps min(- 1), 0.73 +/- 0.17 m, 40 degrees, level 4 respectively for the patient. A paired t-test indicated that differences in the electromyography (EMG) of the tibialis anterior and the quadriceps muscles between patient's disabled (affected-side) foot and normal (unaffected-side) foot are not significant ($p > 0.05$) after 16 weeks of training. CONCLUSIONS: It is concluded that this new knee locker with closed-loop FES system is capable of providing the hemiplegia with restoration to regular walking after appropriate gait training.