# Kinesiological and Kinematical Analysis for Stroke Subjects with Asymmetrical Cycling Movement Patterns

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摘要

**Abstract**

This aim of this study is to provide quantitative analyses of asymmetrical movements between affected and unaffected limbs for hemiparetic subjects in a cycling ergometer. To acquire kinesiological and kinematical data, electromyography (EMG) of quadriceps muscles in the both legs as well as crank positions under three cycling workloads were recorded. The symmetry index (SI) was designed to measure the similarity between muscle activities recorded from affected and unaffected limbs. Using kinematical information of the crank position, the cycling unsmoothness (denoted as roughness index, RI) can be derived from the curvature of the instantaneous cycling speed. Thirteen hemiparetic subjects following a cerebrovascular accident (CVA) and eight able-bodied subjects participated in this study. With total symmetry at SI=1, the average SIs of hemiparetic subjects (0.66+/-0.18) were significantly lower ($p<0.01$) than those of normal subjects (0.91+/-0.08) but no significant difference found among three workloads. From the average RI, subjects with hemiparesis exhibited less smooth cycling movements compared to normal group ($p<0.01$). Non-parametric Friedman and Wilcoxon tests of RIs further indicated that the workload factors are significantly different only for hemiparetic group ($p<0.01$). No significant difference between lower workloads in RIs showed that the CVA subjects' sound side alone can execute most of the cycling load with minimal involvement of the affected side under lower workload condition. When cycling at a heavier load, however, it is essential to force the affected limb to assist in the pedaling, thus accomplishing an effective cycling exercise. By combining these two quantitative indices, we can observe the kinesiological measurement of the symmetry of EMG phasic activities from SI and the kinematical cycling smoothness in a coordinated movement from RI, which could provide a clinical guideline for cycling exercises for hemiparetic subjects