

The role of estimating muscle-tendon lengths and velocities of the hamstrings in the evaluation and treatment of crouch gait

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Abstract

Persons with cerebral palsy frequently walk with excessive knee flexion during terminal swing and stance. This gait abnormality is often attributed to “short” or “spastic” hamstrings that restrict knee extension, and is often treated by hamstrings lengthening surgery. At present, the outcomes of these procedures are inconsistent. This study examined whether analyses of the muscle-tendon lengths and lengthening velocities of patients’ hamstrings during walking may be helpful when deciding whether a candidate is likely to benefit from hamstrings surgery. One hundred and fifty-two subjects were cross-classified in a series of multi-way contingency tables based on their pre- and postoperative gait kinematics, muscle-tendon lengths, muscle-tendon velocities, and hamstrings surgeries. The lengths and velocities of the subjects’ semimembranosus muscles were estimated by combining kinematic data from gait analysis with a three-dimensional computer model of the lower extremity. Log-linear analysis revealed that the subjects who walked with abnormally “short” or “slow” hamstrings preoperatively, and whose hamstrings did not operate at longer lengths or faster velocities postoperatively, were unlikely to walk with improved knee extension after treatment ($p < 0.05$). Subjects who did not walk with abnormally short or slow hamstrings preoperatively, and whose hamstrings did operate at longer lengths or faster velocities postoperatively, tended to exhibit unimproved or worsened anterior pelvic tilt after treatment ($p < 0.05$). Examination of the muscle-tendon lengths and velocities allows individuals who walk with abnormally short or slow hamstrings to be distinguished from those who do not, and thus may help to identify patients who are at risk for unsatisfactory postsurgical changes in knee extension or anterior pelvic tilt.

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1. Introduction

Crouch gait, one of the most prevalent and troublesome movement abnormalities among children with cerebral palsy, is characterized by excessive knee flexion during the terminal swing and stance phases. Abnormally “tight” hamstrings, due to spasticity [1–3] or static contracture [3,4], are thought to cause the excessive knee flexion in many cases. Thus, crouch gait is commonly treated by surgical

lengthening of the hamstrings, typically in combination with other orthopaedic procedures.

Unfortunately, it is difficult to predict which patients will benefit from hamstrings surgery. Many individuals achieve dramatic improvements in knee extension, stride length and walking efficiency following surgery, while others show little improvement or get worse. Previous studies have attempted to explain these inconsistent outcomes by categorizing patients on the basis of preoperative gait kinematics and/or surgical interventions and comparing postoperative changes in knee, hip and pelvis angles during walking across the patient groups (e.g. [5–8]). These studies have provided valuable

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