Compensatory Gait Patterns Secondary to Isolated Ankle Equinus

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Introduction

• Equinus gait pattern
  • Ankle plantar flexion (PF) contracture or tightness
  • Common in the cerebral palsy population, especially in individuals with hemiplegia
  • Equinus gait deviations typically include: increased knee flexion (KF) during swing and through initial contact (IC), and increased hip flexion (HF) during swing
  • In some instances it can be difficult to distinguish primary versus secondary gait compensations

• Clinical question
  • Does an isolated equinus gait pattern alter knee and hip kinematics during gait?
  • When is KF at IC, in the presence of an equinus contracture, a compensation pattern vs. a true deviation?

Purpose

• The purpose of this study was to model an isolated equinus gait pattern to determine if equinus alone results in compensatory knee flexion at initial contact.

Hypotheses

1. Fixed ankle equinus at increasing PF angles will result in increasing knee flexion at initial contact.

Methods

• Subjects: 10 healthy females
  • 22-38 years old
  • Able to fit into a single custom ankle foot orthosis (AFO) and shoes
  • Full knee and ankle ROM/strength
  • No hamstring tightness or contracture, SLR > 50°
  • No history of LE surgery

• Testing:
  • 3D gait kinematics recorded and calculated (Motion Analysis Corp, OrthoTrak®)
  • 5 gait conditions:
    • shoe alone
    • shoe with AFO locked at neutral,
    • shoe with AFO locked at 10°, 20°, 30° PF
  • 8 gait cycles per condition
  • 1 pair of shoes and unilateral AFO for all subjects
  • Velocity controlled
  • Randomized condition order

• Data Analysis:
  • Average gait cycles calculated
  • Primary outcome KF at IC
  • Secondary outcome peak swing HF
  • Repeated measures ANOVA; α < 0.05
  • Post-hoc power analysis

Results

• A model of equinus gait without cofounding factors of hamstring spasticity or contracture found the following results:
  • Equinus conditions >10° PF had both statistical/clinical changes in KF at IC
  • KF at IC was a secondary deviation in 7 of 10 subjects with 6°-22° of KF
  • 3 subjects demonstrated hip hiking, vaulting, and/or lateral trunk flexion as other gait compensations
  • Significant changes occurred between 10° PF and 20/30° PF, no change between 20° and 30° PF
  • As expected, hip flexion was the primary swing phase clearance compensation in all conditions increasing from 31° to 39°

Conclusions

• In a model of isolated equinus gait, controlling for confounding variables such as spasticity or contractures, increased KF at IC occurred with >10° equinus and peak HF increased during swing in all conditions.
  • KF at IC in the setting of < 10° equinus may represent a true gait deviation
  • KF at IC in the setting of > 10° equinus is more likely to be a secondary deviation

Clinical Significance

• Our research found a simulated ankle equinus contracture leads to altered gait patterns of:
  • KF at IC and HF during swing exclusively due to ankle position.
  • This has clinical significance in the realm of CP, specifically when evaluating children with hemiplegia for muscle-tendon surgery, such as a hamstring lengthening. In the instance of KF at IC alone, without a clear clinical hamstring contracture, a hamstring lengthening may not be indicated.
  • To improve gait in children with CP, it is critical to distinguish gait compensations patterns from true abnormalities.

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