

Sagittal Gait Kinematics in Adults with Cerebral Palsy at Gross Motor Classification System I, II, or III With and Without Hamstrings Surgery

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INTRODUCTION:

The hamstrings play an essential role in maintaining the sagittal alignment of the pelvis, hips, and knees while standing in gait. Flexed knee gait in children with cerebral palsy (CP) can be treated with a variety of procedures, including distal femoral extension osteotomy, hamstring transfer, and surgical hamstring lengthening (SHL). Short- and medium-term kinematic outcomes of SHL for individuals with CP have been published. This is the first study assessing long-term postoperative kinematic data from the trunk, pelvis, and knees for two cohorts, one with and one without prior SHL. The primary aim of this study is to compare average pelvic tilt during gait between adults with prior SHL and those without. Secondly, this study will compare average trunk tilt during gait, average knee flexion during stance, and minimum knee flexion during stance.

METHODS:

Fifty-four adults with CP, gross motor classification system (GMFCS) I-III were included. Thirty-two (59%) had SHL performed, on at mean and standard deviation 8 ± 5 years old and 28 ± 14 years before the gait analysis used in this study. Prior surgical history and demographic data were obtained from medical records. Individuals were divided into two groups: those with history of SHL and those with no previous hamstring surgeries. Chi-square tests were used to identify surgeries performed in statistically different amounts between the two groups, these individuals as well as those with revision SHL were removed, and differences in gait parameters were recalculated. Independent samples *t*-tests, and Mann-Whitney U tests compared gait parameters and age between SHL and hamstring surgery naïve groups.

RESULTS:

The cohort averaged 36 ± 13 years old. Age, GMFCS level, sex, race, topography, or ethnicity were not different between groups ($P=0.217-0.612$). Anterior pelvic tilt was significantly greater in the prior SHL group (21.5 ± 9.3 degrees) compared to the group naïve to hamstring surgery (16.4 ± 7.8 degrees, $P=0.037$) (Table 1). Adults with diplegic or triplegic CP and a prior history of SHL were more likely to also have surgical history of bilateral hip flexor lengthening, and right femoral osteotomies. Eleven individuals in the SHL group underwent revision hamstrings lengthening. Removing these individuals as well as those who underwent femoral osteotomies and hip flexor lengthening (20 total individuals) resulted in significantly increased anterior pelvic tilt in the SHL group when compared to the group without prior SHL ($P=0.013$). Additionally, minimum right and left knee flexion, as well as average right knee flexion in stance were significantly less in the SHL group.

DISCUSSION AND CONCLUSION:

These findings suggest that adults with CP and a prior SHL walk with significantly greater anterior pelvic tilt than those without history of SH, even after accounting for other surgeries. Sagittal spinopelvic alignment is correlated with health-related quality of life in typically aging individuals, and increased anterior pelvic tilt has been associated with back pain in individuals with cerebral palsy. When surgically treating flexed knee gait, the effect of SHL on the pelvis should be considered.

Figure 1, Representative Image

No Hamstrings Lengthening Hamstrings Lengthening

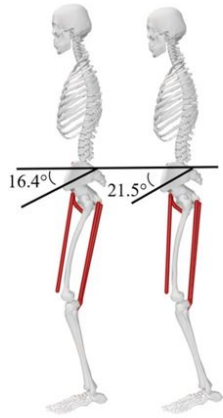


Table 1. A comparison of average pelvic tilt during gait, average trunk tilt during gait, minimum right and left knee flexion during stance, and average right and left knee flexion during stance between adults with diplegic/triplegic CP with and without prior surgical hamstrings lengthening.

*. Significant at $\alpha=0.05$

Gait Parameter	No Hamstrings Lengthening (N=22)	Hamstrings Lengthening (N=32)	P Value
Pelvic Tilt	16.4±7.8	21.5±9.3	0.037*
Trunk Tilt	6.1±9.8	7.2±9.2	0.515
Minimum Right Knee Flexion	14.0±11.2	9.1±16.0	0.220
Minimum Left Knee Flexion	13.3±11.8	9.3±15.0	0.299
Average Right Knee Flexion in Stance	22.6±10.4	17.9±14.2	0.190
Average Left Knee Flexion in Stance	21.9±10.0	18.8±13.7	0.375