A Pre Versus 1 and 5-year Post Operative Comparison of Clinical Examination Measures and Motion Data Related to Knee Function During Gait in Children with Cerebral Palsy

Sylvia Õunpuu, MSc, Ron Lamdan, MD, Kathy Bell, MS, Peter A DeLuca, MD
Connecticut Children's Medical Center, 282 Washington Street, Hartford, CT, USA

Introduction

The popliteal angle and straight leg raise are common tools for the evaluation of knee function and surgical decision making for hamstring lengthening in patients with cerebral palsy (CP). However, it has been shown that there is little correlation between these measures and knee function as documented by knee angle at initial contact and mean knee position in stance during gait[1]. As well, the hamstring lengthening procedure is performed less frequently due to the concern that the hamstrings are already "long" and do not require lengthening in most patients with CP. The purpose of this study was to evaluate the relationship between knee function in gait and clinical measures of hamstring length both pre and post surgery to help better understand the relationship between knee function and hamstring length.

Clinical Significance

Since popliteal angle and straight leg raise are the primary indicators for hamstring surgery it is critical to understand the relationship between these measures and knee function during gait. Caution about performing hamstring lengthening in persons with CP and crouch gait due to concern about "over-lengthening" may have significant negative impacts on gait function over time due to the potential for continued and increasing crouch and associated increased energy consumption problems.

Methods

This was a retrospective study of ambulatory patients with CP. Inclusion criteria were as follows: pre, one year post (post 1) and 5 years post (post 2) surgical gait analyses; intervening surgery as dictated by the pre operative gait analysis; and no other intervening surgeries between the first and second post operative tests. All gait analyses included three dimensional motion data collection and clinical examinations following standard protocols[2] using VICON (Oxford Metrics, UK) hardware and custom software. For this abstract data analysis will focus on clinical examination parameters used to assess passive knee range of motion limitations, that is, the popliteal angle and the straight leg raise and the standard gait parameters used to assess knee function during stance, that is, knee angle at initial contact and mean knee position in stance. A repeated measures analysis of variance was used to evaluate the gait and clinical examination changes over time with Duncan post hoc testing to evaluate all significant findings. A level of $P<0.05$ was established a priori. Pearson correlations were computed to assess potential relationships between clinical and gait parameters.

Results

Eighty-eight patients met the inclusion criteria. Initial evaluation of the relationships between motion and clinical examination measures related to knee function revealed very low correlations. An evaluation of how these relationships changed over time was studied in a subset of 27 sides that had rectus femoris transfers, medial hamstring lengthenings and gastrocnemius lengthenings. The mean age of the subjects at the pre operative test was 11(5)

at post 1 was 12.4(5) and at post 2 was 17(6) years. A summary of the clinical exam and gait changes over time are listed in Table1.

In the subgroup of 17 patients, there also were poor correlations between popliteal angle and knee angle at initial contact before surgery (r=0.2167), at post 1 (r=0.0906) and at post 2 (r=-0.1767). Similarly, there were poor correlations between popliteal angle and mean knee angle in stance before surgery (r=0.1543), at post 1 (r=-0.0006) and at post 2 (r=-0.3852)

Table 1: A comparison of the mean (standard deviation) for clinical exam and motion measures for the knee for pre, post 1 and post 2. (* indicates significant difference between pre and post 1, ** indicates significant difference between post 1 and post 2)

	Straight leg raise (deg)	Popliteal angle (deg)	Knee angle initial Contact (deg)	Mean knee stance (deg)	Peak knee ext stance (deg)	Mean pelvic tilt stance (deg)
Pre	52(9)	-53(12)	31(9)	24(12)	14(13)	19(7)
Post 1	70(3)*	-31(14)*	21(8)*	16(11)*	6(13)*	21(5)
Post 2	55(8)**	-51(11)**	19(9)	16(10)	8(11)	18(7)

Discussion

The results in this study support that there is a poor relationship between knee function during gait and associated clinical examination measures including popliteal angle and straight leg measures. This holds consistent prior to surgery, 1-year post surgery and 5 years post surgery. Of interest, improvements seen in knee function at one year post surgery including knee angle at initial contact, peak knee extension in stance and mean knee extension over the stance phase at one year post surgery are maintained at 5 years post surgery while the related clinical examination measures return to pre operative values. This would suggest that the estimate of hamstring length using these measures does not equate with hamstring function during gait. It has also been reported that hamstring lengthening will result in increased anterior pelvic tilt. The patients in this study showed no change in pelvic tilt position between the 3 gait analyses indicating that proposed increase in length post hamstring surgery did not affect pelvic position during gait. These data suggest that the complex issues related to knee function during gait and the impact of intramuscular lengthening are beyond estimates of muscle length alone. The lack of correlation between clinical exam measures and gait also reinforces the important role of motion analysis in the surgical decision-making process in patients with CP. Future study should be directed at better understanding of the impact of muscle lenthening on neuromuscular parameters, such as spasticity, length and stiffness.

References

1. McMulkin et al., J Ped Ortho. 20(3), 366-369, 2000.
2. Davis R, et al., Clinical Gait Analysis: Current Methods and Future Directions. Piscataway: IEEE Press, 17-42, 1996.

Acknowledgements

Funding for this study was provided by the Robert and Clara Patterson Trust.