Differentiation of Hand Posture In Children with Cerebral Palsy

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Background and Introduction

- Accurate grasp of an object requires planning and coordination of multiple finger joints prior to contact
- Hand posture emerges during reach and reflects object shape early in the reach trajectory in normal adults (Santello 1998, Winges 2003).
- This shaping requires motor planning that may be compromised in children with hemiplegic cerebral palsy

Objective

The aim of this study was to compare differentiation of hand posture to object shape (hand shaping) during reach in typically developing (TD) children and children with hemiplegic CP

METHODS

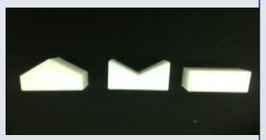
Subjects:

Two groups of children, age range 6-13:

- 10 typically developing (TD) children (mean age 9.7 ± 2.3),
- 10 children with hemiplegic CP (mean 8.6 ±2.7)

Experimental Setup:

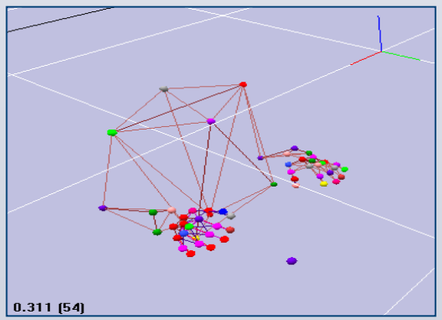
- Subjects grasped rectangular, concave, and convex objects with each hands(7 trials per shape)



Top down view of objects

- MP and PIP joint flexion, digital abduction angles calculated off reflective markers

Experimental setup

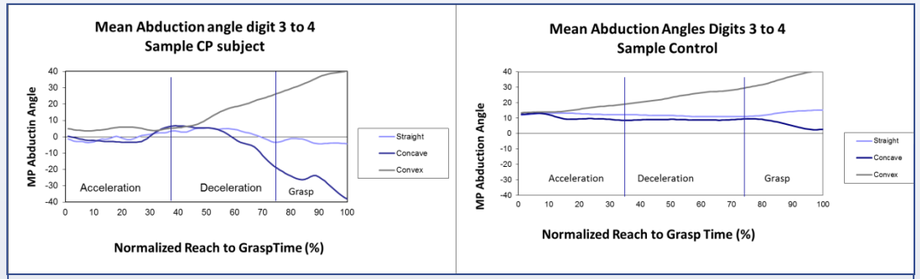


Marker Placement

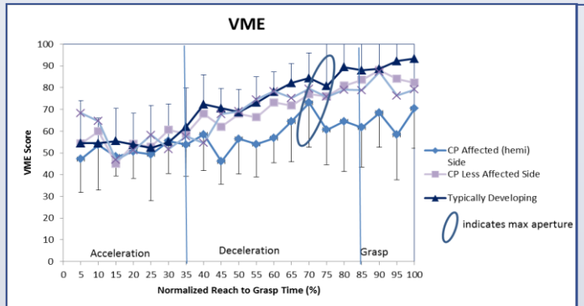
Data Analysis:

- To summarize hand posture across joint angles, discriminant analysis was performed at 5% intervals of reach to grasp movement.
- Results from the discriminant analysis were used to construct a matrix and calculate a "visuomotor efficiency index" (VME score of 100 reflects perfect discrimination between objects), to summarize the extent to which hand posture reflects object shape.
- This methodology allows for subtle detection of changes in joint configuration.
- VME scores were analyzed using a mixed design ANOVA with a between subjects factor of group and a within subjects factor of time

Results



Sample MP Abduction angles . Note: Beginning MP abduction differentiation between concave and convex shape in TD during acceleration, Differentiation in CP does not occur until mid deceleration



- Both CP and TD were able to differentiate posture to object shape, $F_{(1,19)}=8.96$, $p=<.01$.
- CP demonstrated a lower visuomotor efficiency index (VME) than controls in the affected hand during reach, indicating less effective posture differentiation, $F_{(1,18)}=7.69$, $p=.013$
- VME increased later in reach in CP compared to TD $F_{(1,19)} = 2.06$, $p=.006$.
- No difference in hand pre-shaping in the less affected hand in CP compared to TD.

Differentiation of hand posture (VME scores) to object shape. The average VME (± SD) at each 5% interval of the reach is shown in relation to the key reach events (acceleration, deceleration, peak aperture, and grasp), Note that controls increase VME score throughout deceleration and grasp whereas CP begins to increase VME towards the end of deceleration.

Conclusions

- VME is sensitive at detecting shaping differences otherwise not quantifiable
- Children with CP are able to discriminate hand posture to object shape, yet exhibit deficits compared to TD peers in both overall hand shaping ability and timing of pre-shaping on affected side
- Findings suggest unilateral shaping deficit that is independent of motor execution
- These deficits require additional attention in rehabilitation approaches that typically focus on motor execution

References

Santello, M., & Soechting, J. F. (1998). Gradual molding of the hand to object contours. Journal of Neurophysiology, 79, 1307.
Winges SA, Weber DJ, Santello M. The role of vision on hand preshaping during reach to grasp. Exp Brain Res. 2003;152:489-98

Partially funded by: ASHT Evelyn Mackin Grant, AHTF Grab the Evidence Award