# Coactivation index of children with congenital upper limb reduction deficiencies before and after using a wrist-driven 3D printed partial hand prosthesis

Zuniga J.M.

Dimitrios K.

Peck J.L.

Srivastava R.

Pierce J.E.

Dudley D.R.

Salazar D.A.

Young K.J.

Knarr B.A.

Background: Co-contraction is the simultaneous activation of agonist and antagonist muscles that produces forces around a joint. It is unknown if the use of a wrist-driven 3D printed transitional prostheses has any influence on the neuromuscular motor control strategies of the affected hand of children with unilateral upper-limb reduction deficiencies. Thus, the purpose of the current investigation was to examine the coactivation index (CI) of children with congenital upper-limb reduction deficiencies before and after 6 months of using a wrist-driven 3D printed partial hand prosthesis. Methods: Electromyographic activity of wrist flexors and extensors (flexor carpi ulnaris and extensor digitorum) was recorded during maximal voluntary contraction of the affected and non-affected wrists. Co-contraction was calculated using the coactivation index and was expressed as percent activation of antagonist over agonist. Nine children (two girls and seven boys, 6 to 16 years of age) with congenital upper-limb deficiencies participated in this study and were fitted with a wrist-driven 3D printed prosthetic hand. From the nine children, five (two girls and three boys, 7 to 10 years of age) completed a second visit after using the wrist-driven 3D printed partial hand prosthesis for 6 months. Results: Separate two-way repeated measures ANOVAs were performed to analyze the coactivation index and strength data. There was a significant main effect for hand with

the affected hand resulting in a higher coactivation index for flexion and extension than the non-affected hand. For wrist flexion there was a significant main effect for time indicating that the affected and non-affected hand had a significantly lower coactivation index after a period of 6 months. Conclusion: The use of a wrist-driven 3D printed hand prosthesis lowered the coactivation index by 70% in children with congenital upper limb reduction deficiencies. This reduction in coactivation and possible improvement in motor control strategies can potentially improve prosthetic rehabilitation outcomes. © 2018 The Author(s).

Additive manufacturing

Arm

Biomechanics

Computer-aided design

Custom-made prostheses

Hand

Motor control

Pediatric

Reaching

adolescent

Article

child

clinical article

coactivation index

congenital upper limb reduction deficiency

controlled study

electromyography

extensor digitorum muscle

female

flexor carpi ulnaris muscle

human

limb reduction defect

male

maximal voluntary isometric contraction

measurement

muscle isometric contraction

muscle strength

priority journal

range of motion

skeletal muscle

wrist driven 3D printed partial hand prosthesis

limb prosthesis

muscle contraction

physiology

three dimensional printing

upper limb

Artificial Limbs

Child

Female

Humans

Male

Muscle Contraction

Muscle, Skeletal

Printing, Three-Dimensional

Upper Extremity