Influence of Clavicle Movement and Chest Clip Position on Thorax Displacement in Young Children

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Abstract

Displacement of the thorax and head are directly related to displacement of the shoulder girdle. In the event of a frontal crash, the child will interact with the CRS harness, forcing the clavicles posterior, along with the entire shoulder girdle complex. Currently, the 3-year-old ATD shoulder complex may not fully capture this movement. By understanding how the shoulder and clavicle move, we can better predict the overall effect of impacts on the thorax, cervical spine, and head. To our knowledge there have been no studies that have quantified anterior-posterior clavicular displacement of 2-4 year old children. This study seeks to understand the role of chest clip position and harness tightness on clavicular displacement in 2-4 year old children.

The project will include data from twenty children, 2-4 years old. Currently, fifteen subjects have volunteered for this project, after obtaining IRB approval and parental consent. Anthropometry measurements were taken and clavicular motion was captured using an electromagnetic tracking system (trakSTAR, Ascension, Shelburne, VT). Surface electrodes were placed on the: sternum, spinous process of T1, distal end of the right clavicle, right acromion process (of scapula), and right deltoid tubercle (of humerus). Anatomical segments were digitized using MotionMonitor (Innovate Sports Training, Inc., Chicago, IL). Following instrumentation, anterior and posterior passive excursion of the shoulder was measured while the child was holding onto a hand-strap connected to a hand-held digital dynamometer (Baseline Instruments, White Plains, NY). Children were passively pulled into shoulder flexion and extension with 5-10 pounds of force. Each measurement was repeated twice. The Children were then placed in a 5-point CRS (Evenflo Triumph, Evenflo Company Inc.). Clavicular displacement was measured using 4 conditions: proper harness tightness and chest clip position, proper harness tightness with low chest clip position, loose harness with proper chest clip position, and loose harness with low chest clip position. Loose harness conditions were standardized on each child using a 6.3cm block. Each CRS testing condition was repeated 3 times. Anthropometry measurements and CRS scenarios will be repeated using a 3 year-old ATD for comparison.

Anthropometry means and SD will be calculated. Anterior-Posterior displacement (x-axis) of the clavicle will be calculated relative to the sternum in all CRS conditions. Displacement x condition (CRS-Normal, CRS-Low, CRS Lose-Normal, CRS Loose-Low) will be analyzed using MatLab (The MathWorks, Natick, MA). Volunteer data will then be compared to the 3 year-old

ATD. Thus far 15 subjects have been through the protocol with a mean age of 41.8 months ±9.8 months. Preliminary data shows mean anterior clavicular displacement of 2.32cm ±0.86 cm during passive reach; and 2.08 cm ±0.69 cm during passive posterior stretch. The effect of chest clip and harness tightness on clavicular movement will be analyzed upon the completion of data collection.

These data may benefit future 3 year-old ATD shoulder designs or computer models. Understanding clavicular movement relative to chest clip position will help to better predict the effect of impacts on thorax, cervical spine, and head excursion in motor vehicle crashes.