The Center for Child Injury Prevention Studies

Center for Child Injury Prevention Studies
The Children's Hospital of Philadelphia
Research Institute

The Ohio State University
Center for Child Injury Prevention Studies
Defining the Anterior-Posterior Motion of the Shoulder Girdle

Principal Investigator: Laura Boucher, PhD, ATC
Key Personnel: John Bolte IV, PhD; John Borstad, PhD, PT
Students: Saskia Richter, MS, ATC (Anatomy PhD Student)
Karolina Ostapkiewicz (BME UG)
Jared Seidel (BME/ME UG)

Mentors: Eric Dahle, Phil Przybylo (Evenflo), John Combest (Nissan), Jerry Wang (Humanetics), Hiro Tanji (Takata), Jack Jenson (GM), Taft Jones (Graco), Jason Gainey (VWGoA)
Background

- Motion of the head, cervical spine and thorax during impact are heavily dependent on the response of the shoulder girdle complex.
Pediatric vs. Adult

- Decreased forward posture
Background

Pediatric vs. Adult

• Increased upward rotation
Pediatric vs. Adult

- Increased anterior tilting
• Anterior-posterior motion of the shoulder girdle has not been evaluated
  – In a CRS the shoulder harness rests on the middle 1/3 of the clavicle
  – During a frontal crash, the harness forces the clavicles posteriorly, which directly impacts the amount of head excursion
Background

• Chest clips help minimize anterior thoracic motion
  – Position of the chest clip is one of the most frequent mistakes made\textsuperscript{5,7}
Goals

• Investigate quasi-static response of the shoulder girdle in children 2-4 years old

• Aim I
  – Quantify anterior-posterior clavicular displacement in children 2-4 years old
    • While seated on custom chair and in CRS

• Aim II
  – Evaluate the influence of chest clip position and harness tension on posterior clavicle displacement and thorax & head excursion
    • For volunteers and the 3 year old ATD
• Research Category:
  – Injury biomechanics, mechanisms, and tolerance

• Student Involvement:
  – Saskia Richter, MS – Anatomy PhD Student
    • Methods, data collection and analysis
  – Karolina Ostapkiewicz – BME UG
    • Methods, data collection and analysis
  – Jared Seidel – BME/ME UG
    • Testing materials fabrication and data collection
Methodology

• 20-25 pediatric volunteers
  – 2-4 years old
  – No history of shoulder injury
  – Male & female

• Height, weight and appropriate anthropometry will be recorded
  – Acromial distance
  – Clavicular length
  – Humeral length
  – Chest circumference
Methodology

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Methodology

• trakSTAR ("Flock of Birds")
  – 6 degree of freedom, electromagnetic tracking system
Methodology

• 7 Sensors
  – Right Humerus
  – Right Scapula
  – Right Clavicle
  – Left Scapula
  – Left Clavicle
  – Sternum
  – T1
Methodology - Aim I

• Volunteers will be seated in a custom chair fixture.
Methodology - Aim 1

Testing

- Active anterior excursion: x2
  - Self “hug”
  - Both on chair and in CRS
- Passive anterior excursion: x2
  - Lean against stabilizing plate, grip double grip hand strap, researcher will pull arms into flexion
  - Both on chair and in CRS
- Passive posterior excursion: x2
  - Arms behind back through double grip hand strap, researcher will pull arms into extension
Methodology - Aim I

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Methodology - Aim 1

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  – Both on chair and in CRS

• Passive posterior excursion: x2
  – Arms behind back through double grip hand strap, researcher will pull arms into extension
Methodology - Aim II

- Children seated in the CRS
- Lean forward as far as they can
  - 3 levels of chest clip will be tested
    - Proper, Middle, and Low
Methodology - Aim II

- Repeated with a loose harness
Methodology - Aim II

• ATD will be positioned and tested in the same manner as volunteers
  – Testing conditions may result in data collection with FARO arm instead of trakSTAR
Methodology - Aim II

- Data Collected with MotionMonitor
Conclusion

• The amount of anterior-posterior clavicular displacement will be defined for an average 2-4 year old

• The amount of thorax (and head excursion) will be mapped vs. various heights and harness tensions of the chest clip

• The ATD will be measured and compared to the volunteers to see if the ATD is underestimating thorax displacement (and head excursion) due to the lack of a biofidelic shoulder complex
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## Proposed Timeline

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Proposed Budget

• On track
  • Total: $31,286
    Personnel: $24,606
    Supplies/ Recruitment: $3,680
    Travel: $3,000
Anticipated challenges and proposed solutions, intellectual property

• IRB & Subject Recruitment
  – IRB approved!
  – OSU has a strong history of subject recruitment, considered a minimal challenge

• Looking to acquire a Q3 or Hybrid III ATD (for Aim II)


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