Reducing Rotational Acceleration Generated by Oblique Football Helmet Impacts

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Background

- 5.2 million people over the age of 6 play tackle football
- Pro American Football starts in 1892
- Plastic helmet implemented in 1950
- Helmet drop test pros and cons
- Oblique impacts are the worst
Justification

- Brain injury lifetime cost $85,000 - $3,000,000
- 46,000 Football related head injuries yearly
- Estimated yearly cost of brain injuries: $71 Billion
- Our estimated impact(0.5%): $355 Million
- Does not account for chronic traumatic encephalopathy
Previous Investigations

● Various methods of studying football helmet impacts
  ○ Analysis of video replays
  ○ Simulation using finite element analysis

● Both linear and rotational forces are present in football helmet impacts
  ○ Can lead to concussion

● National Operating Committee on Standards for Athletic Equipment (NOCSAE) conducts 26 drop tests from varying heights onto different positions of football helmets
  ○ Only tests linear impacts, does not test for rotational forces
Current Products

- Schutt F7 helmet
- VICIS Zero1 helmet
- ShieldX Technology BX-E gliding layer
Proposal

Aim 1: To compare current helmet testing to helmet testing that also takes into account shoulder pads.

Aim 2: To evaluate the effectiveness of using neck padding attached to shoulder pads to reduce oblique forces on the head.
Kinematic Explanation
Aim 1: Helmet testing with shoulder pads

Materials:

- A 50th Percentile Male Hybrid III anthropomorphic testing device will be used to couple the helmet and shoulder pads for testing
- An array of MSI Model 64C-2000 accelerometers and DTS ARS PRO-8k angular rate sensors will be used to measure linear and rotational accelerations
- Testing will be done using a Riddell Speed Icon helmet and Riddell Rival Varsity shoulder pad
Aim 1: Helmet testing with shoulder pads

Methods:

- Test impacts at nine locations, four of which are oblique.
- Use an air ram and adjustable table for positioning.
- First trial with just the helmet, second trial with helmet and shoulder pad.
Aim 1: Expected Results

- There will be a slight decrease in linear and rotational accelerations depending on the point of impact.
Aim 2: Evaluate neck padding

Materials and Method

- Male Hybrid III, MSI Model 64C-2000 accelerometers, DTS ARS PRO-8k angular rate sensors, Riddell Speed Icon helmet, and Riddell Rival Varsity shoulder pad. Same as aim 1
- 9 impact locations using an adjustable air ram as in aim 1
- Test trials for no padding and 1” thick padding with stiffnesses of 10 Mpa, 50 Mpa, 100 Mpa, 500 Mpa, 1 Gpa
Aim 2: Expected Results

We expect the resultant force to be inversely proportional to the stiffness of the padding for oblique forces and to remain constant for non-oblique forces.
Future Directions

- Further experiments to see how new technologies work in conjunction with shoulder pads and neck pad
- Also experiment with equipment from other contact sports such as hockey and lacrosse
References


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Questions?