D7 A Comparison of Modern Youth Football Helmet Design Impact Attenuating Performance With Measurements Made in 1992 for the Helmet Design of a Fatally Injured High School Player

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The goal of this presentation is to demonstrate the means for comparing and assessing designs of current youth football helmet impact performance in front, side, and rear locations versus impact results of a high school football helmet design tested decades earlier (i.e., 1992) in relation to the forensic analysis of a fatally injured 17-year-old high school football player.

This presentation will impact the forensic science community by informing attendees that helmet Severity Index (SI) test data certification measures of new and reconditioned youth football helmets should be made available to the public so parents, coaches, school administrators, and forensic researchers can compare SI impact safety performance levels and identify those helmets that provide uniformly optimum safe levels, throughout all regions of a youth helmet, when tested at realistic impact energies consistent with the speed of players. This type of evaluation would be beneficial for improving youth football player safety and would assist in improving helmet designs.

Head injury and concussion risk to high school and youth football players has recently received attention, including interest by the United States Congress, due to research by Omalu and McKee regarding repeat impact brain damage to professional football players diagnosed with Chronic Traumatic Encephalopathy (CTE).[1-4] Testimony by the National Football League (NFL) before Congress in 2009 suggested "optimism" regarding the safety of newer helmets, compared to older helmets used by CTE-injured players.[1] Unfortunately, research on contact-impact safety of current youth football helmet designs reveals similarities to non-uniform, dangerously high head impact loads seen in older helmets, such as those worn by athletes diagnosed with CTE, when compared to 1992 tests on the helmet of a deceased high school player.[5-7] Energy-absorbing padding in the frontal area of a forensically examined football helmet consisted of a dual-density elastomeric foam (Fig. 1.) Linear contact-impact testing used a certified National Operating Committee on Standards for Athletic Equipment (NOCSAE) drop-impact fixture. Repeat impacts were conducted at 5.5m/s (6.6 second 40-yard dash) with energy of 108 Joules (J). Figure 1 illustrates 1992 helmet compliance with NOCSAE head SI limit of 1,200, but the frontal helmet padding provided the least amount of protection in comparison to the side and rear. More importantly, the SI frontal measures were at or above current National Highway Traffic Safety Administration (NHTSA) Head Injury Criteria (HIC) Injury Reference Value (IRV) of 700 (denoting approximately 7% of the United States population would be at risk of severe head injury with this HIC value).[8] Data also demonstrated a wide disparity of SI measures from front-, side-, and rear-impact locations by approximately 30%. A safe design should not have such wide disparity in injury measures for a given impact energy, but should provide low SI values uniformly at all helmet impact locations.

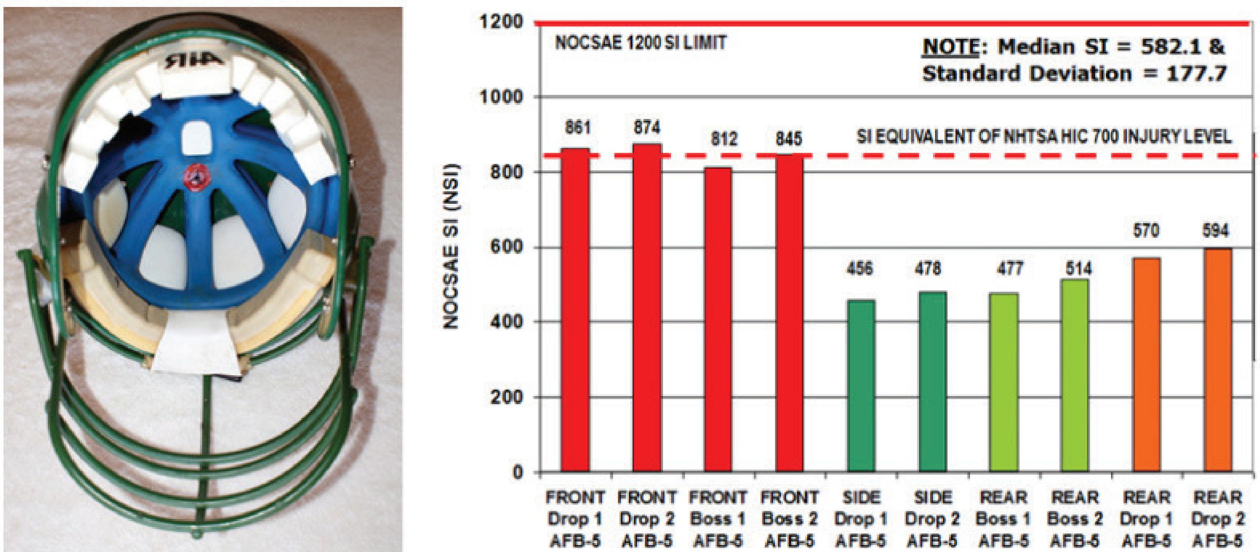

Fig-1. NOCSAE Severity Index Data from 1992 Helmet Design Used by a Fatally Injured High School Player

Comparison of the 1992 NOCSAE SI test data measures for the helmet (Fig. 1) of the fatally injured high school player with recent NOCSAE SI test data of a 2014 Youth Helmet design (Fig. 2) demonstrate that both helmet designs have impact regions exceeding NHTSA HIC 700 IRVs. The danger region of the helmet shown (Fig. 1) was the frontal area, the injury location of the high school player; the danger region of the helmet show in Fig. 2 was the rear (occipital) area. In both cases, the high SI measures deal with response from elastomeric foam impact attenuating "Energy Absorbing" (EA) materials. A positive, or "optimistic," aspect of the 2014 Youth helmet was the incorporation of a newer EA "Thermoplastic-Urethane" (TPU) waffle-pattern material in the front of that helmet (blue frontal material in helmet on left of Fig. 2). While this newer TPU material provides some improvement for direct contact-impact, recent studies by Saczalski et al. indicate head injury risk from rotational accelerations remains a problem with these materials, and that the rotationally induced danger and injury measures are still not part of the NOCSAE helmet safety performance criteria injury evaluation.

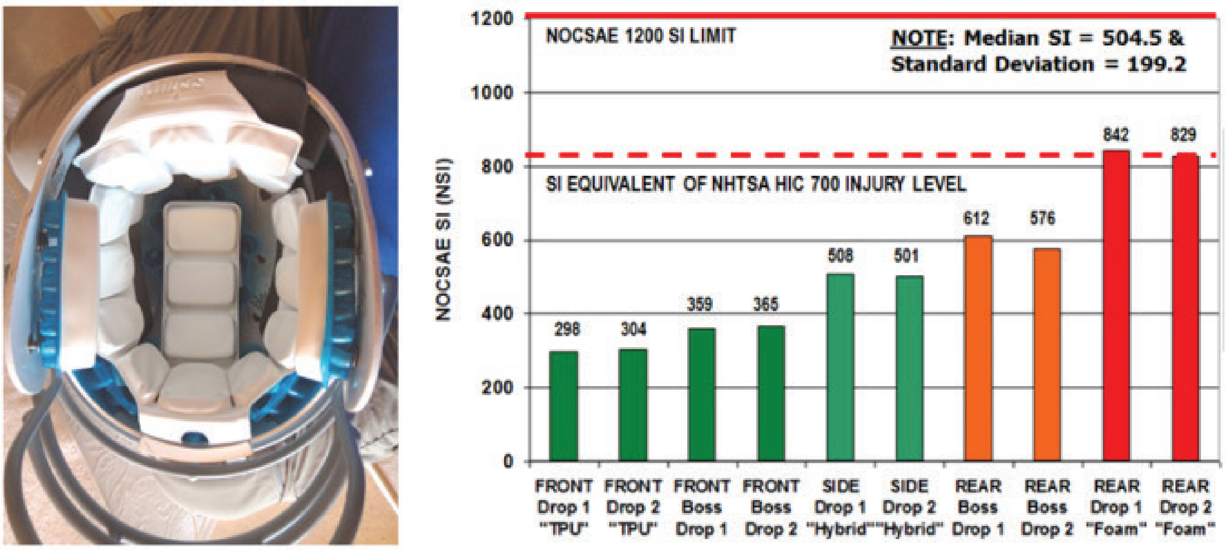

Fig-2. NOCSAE Severity Index Data from 2014 Peewee Youth Helmet Design Approved for Peewee Play

Summary: "Optimism" regarding the efficacy of football helmets to attenuate concussive level impact forces should, unfortunately, be tempered by the reality of recent research, rather than relying solely upon the assurances of NOCSAE and football helmet manufacturers using outdated safety certification testing and injury reference levels.[1,5,6] Ultimately, the NFL and the sport of football need a more rigorous engineering approach to design safer helmets, such as "multi-variable" methods enabling performance assessment for linear impact and rotational injury measures, plus ambient, high-humidity, and temperature conditions.

Impact: NOCSAE helmet test data should be made readily available so the public can compare SI impact performance levels and identify helmets providing uniformly optimum safety in all regions, when tested at realistic impact energies consistent with actual player speeds. This would benefit football player safety and facilitate improvements in helmet design or materials.

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Youth Football Helmets, Football Helmet Testing, Concussion Risk