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A COMPARISON OF WEARABLE HEAD IMPACT SENSORS

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ABSTRACT

It is estimated that there are as many as 3.8 million cases of sports-related concussions each year with half of all concussions going unreported or undetected. The increasing concern regarding mild traumatic brain injury has led to the development of wearable head impact sensors (WHIS). These sensors help give a better understanding of the quantity and magnitude of head impacts sustained by an athlete during a season of participation. Frontal and lateral impact tests were performed at 6.3 and 8.8 m/s using a rigid arm pendulum. A medium National Operating Committee on Standards for Athletic Equipment (NOCSAE) headform with a modified jaw was fitted with a 50th percentile male Hybrid III neck and a large Riddell SpeedFlex helmet. The WHIS that were tested were the Simbex Head Impact Telemetry System (HITS) and the Prevent Biometrics Impact Monitor Mouthguard (IMM). These sensors were compared to the reference sensor package of 3 linear accelerometers and 3 angular rate sensors located in the center of gravity of the NOCSAE headform. The HITS recorded higher peak linear acceleration (PLA) and peak rotational acceleration on average than the reference sensor (+13% and +17%, respectively), while the IMM recorded lower PLA (-21%) and PRA (-14%) on average. These differences were more extreme in the lateral versus the frontal impact tests. This information will be helpful in determining the accuracy of WHIS data that is collected in on-field settings.

Keywords: mTBI, concussion, sensor, pendulum

INTRODUCTION

It has been reported that nearly 4 million sports-related concussions occur annually [1]. In the contact sport environment, concussions result from head impacts that lead to linear and rotational accelerations of the head. To get a better understanding of head impact biomechanics, several wearable head impact sensors (WHIS) have been developed. Commercially available WHIS come in a variety of packages and include helmet-mounted, mouthguards, skin-mounted patches, headbands, skull caps, and sensors that fit within the ear canal [2]. Many sensor systems have the option to alert a member of the team's staff when a player sustains an impact above a certain threshold. In recent years, studies have been performed in both laboratory [3-8] and field [9, 10] settings to validate these sensors. When using WHIS to study head impact biomechanics, it is important to understand the limitations of the sensors in terms of the frequency, directionality, and magnitude of the head impacts, as no sensor is 100% accurate. WHIS have the potential to allow for real-time monitoring of head impacts that may reveal important information about an individual athlete's playing style. Athletes who are found to be at risk for head injury based on the characteristics of their head impact exposure could receive additional coaching to modify their playing style. The aim of this study was to test the accuracy of two commercially available WHIS in a laboratory environment.