Medical Xpress

Research supports 'structural health monitoring' to reduce head trauma in contact sports

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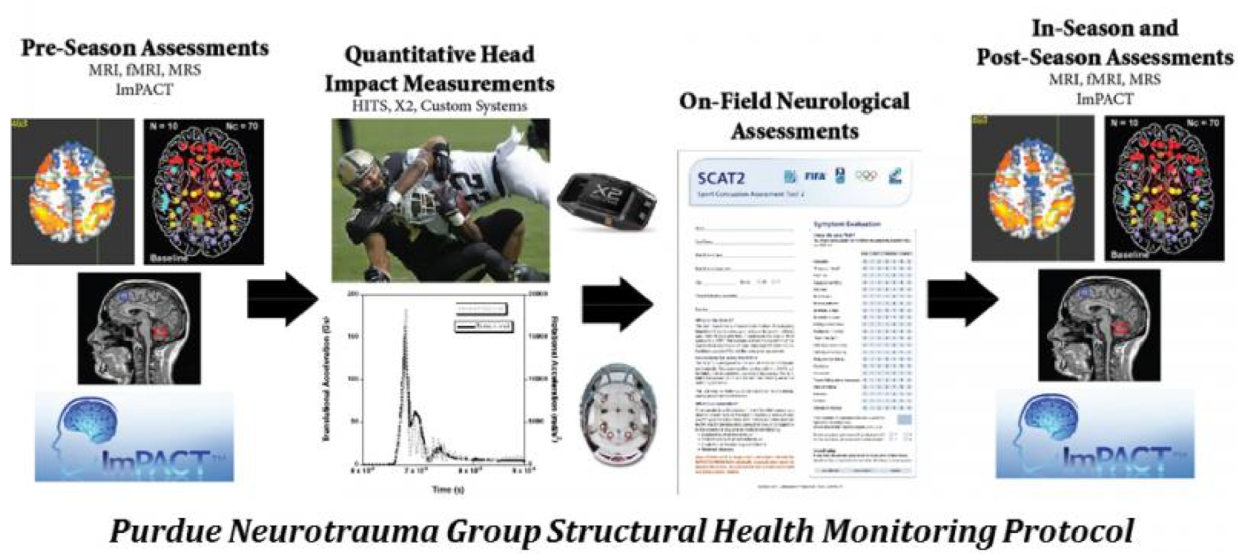

Figure 5

Researchers are advocating a greater use of medical imaging to reduce brain trauma in contact sports. They also are recommending that a "structural health monitoring" approach similar to that used to detect subtle damage in aircraft also be applied to athletics to better understand the effects of gradual neurological damage. Credit: Purdue University image/Purdue Neurotrauma Group

Researchers citing data on the effects of repeated head impacts on high school football players are advocating a greater use of medical imaging to reduce brain trauma in contact sports, particularly in players who do not have symptoms of concussion.

The researchers are recommending that a "structural health monitoring" approach similar to that used to detect subtle damage in aircraft also be applied to athletes to better understand the effects of gradual neurological damage. So-called mild traumatic brain injury represents a major health danger because new data suggest it could lead to concussion and serious long-term health effects.

"We are saying that medical imaging can be used in re-characterizing traumatic brain injury, as a whole, to better identify at-risk individuals and improve the development of preventative and interventional approaches," said Thomas Talavage, a Purdue University professor of electrical and computer engineering and biomedical engineering and co-director of the Purdue MRI Facility. "New data are revealing that athletes appear to be impaired for most of the year, not just during their competition seasons, and that they may not be fully recovering between seasons."

While most research focuses on the effects of brain trauma after a concussion has occurred, work should also concentrate on preventing concussion by identifying a series of milder injuries that could lead to concussion, the researchers say.

Findings are detailed in a paper appearing this month in *Frontiers in Neurology*. The paper was authored by Talavage; Eric Nauman, a professor of mechanical engineering, basic medical sciences and biomedical engineering; and Larry Leverenz, clinical professor in the Department of Health and Kinesiology and an expert in athletic training. The researchers lead the Purdue Neurotrauma Group, which has studied brain changes in high school football players since 2009, spanning seven seasons. Their work also has examined high school soccer players.

Structural health monitoring detects subtle damage in aircraft and other structures using technologies such as computed tomography, X-rays, ultrasound and magnetic resonance imaging, revealing otherwise undetectable damage that could lead to catastrophic failure.

"These tools ultimately became the foundation for the field of structural health monitoring, which has dramatically improved safety in the airline and automotive industries, military, and the food industry," Nauman said. "It is reasonable to propose that structural health monitoring may be effectively applied to enhance brain health in cases where neurotrauma is a potential outcome. Such an approach necessitates that one interpret traumatic brain injury as a condition where an individual may gradually accrue symptom-inducing injury."

Recent research has shown changes in brain chemistry and metabolism even in players not diagnosed with concussions.

"Integration of neuroimaging and biomechanical studies in youth collision-sport athletes has revealed that significant alterations in brain structure and function occur even in the absence of traditional clinical markers of concussion," Nauman said. "Changes in brain metabolism will induce responses from brain cells that seek to restore the ionic balances associated with 'healthy' function. If we recognize these responses as efforts at 'repair,' we must also recognize that the alterations to metabolism represent 'injury,' even if they do not represent permanent structural or biologic alterations."

To help prevent concussions, sensors might be integrated into helmets to track hits to the head and to monitor how well the helmet is absorbing the blows.

"It's important to think about intervention steps that can be taken to better protect the players," Leverenz said. "Perhaps we can change the hardware, change the helmets, change techniques and training regimens."

While it is not now practical to use magnetic resonance imaging technology to routinely monitor athletes, the imaging may serve as a "gold standard" for the assessment and validation of more portable diagnostic alternatives, Nauman said.

"One of the greatest benefits of structural health monitoring using imaging will be the ability to quantitatively validate new procedures or equipment intended to produce greater brain health," he said. "A large number of products are currently being marketed with claims of enhancing safety, but for which evaluations are predicted with outdated or inappropriate testing procedures. The prospective feedback associated with structural health monitoring, particularly when combined with neurophysiologic assessments, can permit the claims from these and future advances - be they equipment, training techniques or therapeutic agents -to be verified or refuted in the target subject populations under meaningful field conditions."

Since 2009 the Purdue Neurotrauma Group has studied high school collision-sport and non-collision-sport athletes, following the general design of structural health monitoring, with MRI serving as the primary method of non-destructive evaluation.

"Data collected in the PNG study demonstrate that collision-sport athletes accrue injury over the course of a season," Talavage said.

In the sixth year of the PNG research, high school collision-sport athletes exhibited increasing rates of "deviant neurological assessment measures" as the season progressed and into the beginning of the next season when compared with non-collision-sport high school athlete controls.

"The contact-sports athletes finally saw a recovery close to that of the control population four to five months after the end of the first competition season," Nauman said. "The data raise concerns about the increasingly year-round nature of many youth athletic activities. Even at the time traditionally assumed to represent a 'healthy' measurement - immediately prior to the beginning of practice activities - the athletes are, in fact, altered relative to their non-collision-sport peers. This alteration is likely a result of summer practices, summer camps, and participation in summer competitions including football tournaments and travel soccer teams. So it appears the athletes are truly closest to being healthy, or are most neurophysiologically like their non-collision-sport peers, in the late spring, a time at which most spring practices or seasons now commence for traditional fall sports."

The team also is developing new protective technologies such as more effective energy-absorbing materials for football helmets, which have been licensed through the Purdue Research Foundation's Office of Technology Commercialization.

"Helmets have remained fundamentally unchanged for decades and are designed to prevent skull fractures, not concussions," Nauman said.

More information: The Role of Medical Imaging in the Re-Characterization of Mild Traumatic Brain Injury Using Youth Sports as a Laboratory, *Frontiers in Neurology*, 2016.

Provided by Purdue University