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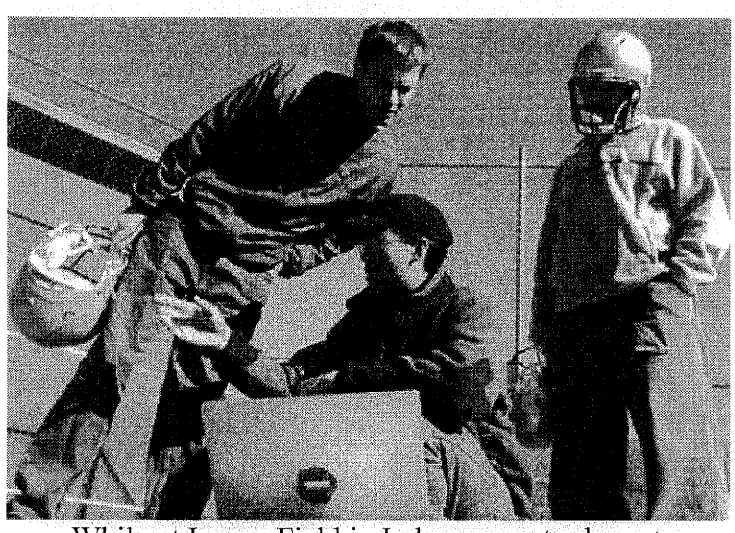

While at Logan Field in Lebanon yesterday, Simbex engineers (from left) Aaron Buck, Jeffrey J. Chu and Jonathan Beck test their equipment that measures the head impacts endured by football players.
(Valley News — Tom Rettig)

Understanding Concussions

By Donald Mahler

Valley News Sports Editor

It's football. It's a collision sport rife with violent hits. And those hits can ofttimes lead to injuries, sometimes serious injuries.

As serious as a concussion.

"I don't think you can play football without, at some point, getting a concussion," said Jeff Frechette, Dartmouth College's head athletic trainer.

That fact drives the research done by Rick Greenwald and his team at Simbex, a Lebanon company that developed the Head Impact Telemetry (HIT) System, a biofeedback device that monitors what happens to players' heads when they take a hit on the football field.

In this fall's college season, Simbex has taken its research from the laboratory to the playing field in a big way. Last year, Simbex monitoring devices recorded 3,300 impacts on 38 Virginia Tech players. This year, the HIT System is also monitoring players at the University of North Carolina and

perennial powerhouse University of Oklahoma.

There is no shortage of data. "We have recorded 10,000 impacts in 50 players through September," said Greenwald, also an associate professor at Thayer School of Engineering at Dartmouth.

While it's too early to draw firm conclusions from the data -- and to gauge the implications for injury treatment and prevention -- Greenwald said that initial reports have yielded some fascinating results.

In the study of Virginia Tech players last year, for instance, the helmet monitors showed that players receive an average of 50 hits to the head in a game, each with an average force of 40g -- or 40 times the force of gravity.

"What we have learned is that the number of hits in practice and games is much higher than we originally thought," said Greenwald.

The data being recorded now will give football staffs more insight into which kinds of hits lead to concussions, alert trainers and coaches in real time to injuries their players might not be talking about and also lead to different kinds of tackling techniques to avoid head injuries.

And as a by-product of all this research, new and safer helmet design is also possible.

"Most of the impacts we've seen are of a relatively low level," said Greenwald. "Linemen are hit on every play, but these are relatively low impact. However, there are hits that reach the 100g range, which is like a car hitting a wall at 25 mph. And we have recorded impacts as high as 180g."

Not all high-level impacts result in a concussion, Greenwald said. But the ability to monitor them should yield insight into the kinds of hits that will lead to concussions.

"For the first time we are able to measure on-field magnitude, severity and impact location on the head. It allows us to test various hypotheses related to what causes concussions. It is the necessary first step toward understanding what specific impacts lead to concussions."

Stefan Duma, the director of the Center of Injury Biomechanics at Virginia Tech, said the study has already proved valuable. "We're learning a lot that will let us better understand the concussion injury threshold, how to develop new and safer helmets, plus get more information on how to evaluate and treat concussions," Duma said.

The lightweight HIT System measurement device fits inside a player's helmet and measures impacts with a microcomputer, a wireless receiver and tiny accelerometers much like the ones used to activate airbags in car crashes. It measures and records the location, number, frequency and severity of impacts.

Of the 10,000 hits seen this year, five have been recorded concussions.

A concussion is a temporary change in the way the brain works when it is suddenly moved or jarred -- knocking against the skull's bony surface -- after a blow to the head. Victims of concussions may face other problems as well, including second-impact syndrome -- which can be extremely dangerous if a second concussion occurs while someone is still suffering the effects of a previous one. Multiple concussions also can have long-term effects, including memory loss and a decline in brain function.

The National Football League also has been doing research into concussions. In recent years, the careers of high-profile players like wide receiver Al Toon of the Jets and quarterbacks Troy Aikman of the Cowboys and Steve Young of the 49ers have been cut short by concussions.

A five-year study that came out in October 2003 used video analysis, modeling and a test dummy to re-enact hits from 31 NFL game concussions from 1996 to 2001. The findings suggest that most of the concussions were caused by direct hits; most often blows to the facemasks, sides or backs of the helmets. (Since football programs at all levels now preach against spearing -- launching yourself into an opponent headfirst -- blows are more rarely seen at the top of the head.)

But that work was done in the laboratories, not in real-time (as it happens) game situations with actual players.

"That's where we can add to the picture," said Jeff Chu, director of engineering at Simbex.

Taking a Hit

A player gets his "bell rung" after a particular hit and either the player, a coach, a teammate or a trainer notices one of the telltale signs -- headachy feeling, dizziness, confusion, lack of feeling or emotion, anxiety, blurred vision, vomiting or the inability to remember events prior to the injury. A player does not necessarily need to lose consciousness in order to sustain a concussion.

The sideline staff may not see the actual hit that caused the injury. And that's where Greenwald and the HIT System could make a difference after the data are gathered and processed. "We want to alert the sideline staff in real time that a significant blow has occurred on the field," said Greenwald.

To do that, the HIT System uses thresholds that, if exceeded for a particular hit, issue an alert through a pager carried by a member of the medical staff on the sidelines and indicates by number the player that should be looked at by the trainer.

Evaluating the HIT System could also help develop a protocol about what

kind of a hit either constitutes a concussion or will lead to a concussion, eliminating subjectivity. "Anything that will add to the science to make things more objective is great," said Dartmouth's Frechette.

Greenwald said, "the HIT System will never replace the doctors' or trainers' skilled opinions and decisions. All we are doing is putting another tool in the belt."

What that tool does is take the subjective element of the player's desire to stay on the field out of the hands of the players … and even of the coaches.

"These are highly motivated kids who know what to say, and what not to say (if they want to avoid getting sidelined)," said Frechette.

A Helping Hand

Gary Mayo, the risk management adviser to Simbex and an assistant football coach at Lebanon Junior High for the past six years, sees another application of the HIT System that could help coaches at all levels keep their players safer in the future.

"If you see too many hits to the top of the head, then you know that proper (tackling) technique is not being used. At that point, the science becomes a teaching tool, while at the same time it can help avoid the potential of a catastrophic neck injury," Mayo said.

At Virginia Tech, Duma has seen unwavering support from the football coaching staff. "They are very excited about anything to do with player health," Duma said. "They understand what we're doing will help gain an insight into concussions. On any level, that's a positive step."

The Simbex system is the first to measure on-field head impact for a large numbers of players. And that is the key to this study, according to Greenwald.

"It's important to get a lot of people -- because the incidence of head injury is relatively low -- to understand what does and what does not cause concussions," he said.

"The HIT System allows us to track players' cumulative history over time. And that is important because most researchers believe that cumulative impacts -- not just one impact -- may be significant in terms of sustaining more concussions and also long-term cognitive deficits."

Greenwald said he chose football first for his work on concussions because the sport is such an impact-rich environment. But the same concepts apply to many other sports, including hockey, lacrosse, soccer, boxing and skiing.

The future applications of this study will be beneficial to more than just the elite athletes of the NFL or college programs. According to Mayo, the

president of A.B. Gile Insurance, "If it becomes clear that this is a useful and widely available predictive tool -- in real time -- then the pressure may be on school districts in the future to hasten acceptance and spend money on it.

"If the data shows that football players are better off with (the HIT System) in their helmets than without, it wouldn't surprise me if it happens in a number of years."

New Insights

Using college football players in actual game situations has given the scientists and medical people new insights into understanding concussions.

"Early data suggests different (player) positions see different numbers and severity of impacts. The greatest severity is seen in linebackers (on defense) and wide receivers (on offense)," said Greenwald.

"We can't say that *this* impact caused a concussion," he added, "But we can identify for sideline personnel when impact of some level has occurred. Then they can do their medical care."

On the Dartmouth sidelines, Frechette and his staff have seen a half-dozen concussions this season, a number they said is typical. "We tell (the players) if you don't tell us and continue playing, there's a greater chance of sustaining a more serious concussion the next time," said Frechette's assistant, Scott Roy.

"We come down on the side of being conservative with the kids," continued Frechette, who has been at Dartmouth since 1981. "We've had kids in the past who we've had to shut down for repeated concussions. But the kids understand that it's their brains and not football that is going to get them what they want out of life."

Earlier this year, Simbex teamed with Dartmouth Medical School and Dartmouth-Hitchcock Medical Center researchers Tom McAllister, Tina Duhaime and Art Maerlender to submit a multiyear research proposal to the National Institutes of Health to use the HIT System to better understand the basic biomechanics of concussion. This research would include a multi-institution field study that could include the Dartmouth football and men's and women's hockey teams.

And Simbex has recently partnered with industry leader Riddell to commercialize the HIT System for widespread use at all levels of play.

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