Defense and Veterans Brain Injury Center "Clinical Updates in Brain Injury Science Today [CUBIST]" Podcast
"Neuroimaging of sport concussion: persistent alterations in brain structure and function at medical clearance"
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Host: Dr. Don Marion, MD

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Episode 109: Spot Concussion and Neuroimaging

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Marion: Hi! Welcome to Clinical Updates in Brain Injury Science Today, or CUBIST, a biweekly podcast for health care providers about current research on traumatic brain injury, also known as TBI. This program is produced by the Defense And Veterans Brain Injury Center, otherwise known as DVBIC. I'm your host today, Don Marion. I'm a neurosurgeon and senior clinical consultant at DVBIC.

In today's episode, I'll be talking with Dr. Anne Bunner. Dr. Bunner is a biologist and program analyst here at DVBIC. Anne and I will discuss a study entitled: Neuroimaging of sport concussion: persistent alterations in brain structure and function at medical clearance. This article was recently published in the Scientific Reports by Churchill and colleagues.

Marion: Anne, hi and welcome.

Anne Bunner: Hi, thank you Don.

Marion: Great study, great pick. What was the key take-away message from this study?

Bunner: The authors found that small brain abnormalities are still present even after the athletes recovered from their concussion symptoms and had been told by a physician that they are ready to return to play. The authors used the phrase "persistent alterations" to emphasize there were no

significant changes between the scans taken within days of concussion and the scans taken after clearance to return to play.

Marion: We're talking about this whole issue of who can return to play and safely returning the athlete to play. I guess to put this in context we've been talking a lot in the past about just focusing on the symptoms, and here the study is starting to say, "Well there's another aspect, it's the imaging." Who were the participants? How old were they and gender?

Bunner: All of the 54 participants were college athletes. Half of them had a physician diagnosed acute concussion, and they were matched one-to-one with controlled athletes based on age, sex, and life-time concussion history. The 27 control participants had no recent concussions. About half the participants were women.

Marion: Which sports are we talking about?

Bunner: The athletes were drawn from nine different sports, including rugby, volleyball, football, lacrosse, basketball, and soccer and others.

Marion: How were they assessed?

Bunner: Post-concussion symptoms were assessed with the sport concussion assessment tool, or SCAT3, which assesses self-reported symptoms, balance, memory, and concentration. Brain structure was assessed using diffusion tensor imaging, or DTI.

Marion: SCAT3, unusual name. Is that a commonly used instrument for post-concussion assessment?

Bunner: It is commonly used. Although the current version is the SCAT5, the sport concussion assessment tool, or SCAT, is published by the Concussion and Sport Group that also publishes consensus recommendations, commonly known as the Berlin Consensus. I discuss this consensus statement with Inbal in the fifth episode of CUBIST entitled "Sport Concussion Consensus Statement."

Marion: How is the SCAT different than the MACE? Are they similar?

Bunner: The SCAT is more detailed than the MACE and a little bit longer.

Marion: Ok. Anne, what was the timing of the neuro-imaging scans or studies that you referred to relative to the time of their concussion?

Bunner: Concussed participants were brought in for initial assessment a median of 4 days after injury and again after medical clearance to return to play. Time to clearance varied widely with a median around 7 days.

Marion: Most of our listeners probably know this, but can you briefly explain to us "DTI"?

Bunner: Diffuser Tension Imaging, or DTI, is a type of magnetic resonance imaging approach that can reveal brain microstructure based on the diffusion of water. The specific parameters that are extracted

from these scans are called fractional anisotropy, or FA, and mean diffusivity, or MD. These parameters directly relate to the diffusion of water immolated axons, but they also provide information about axonal integrity.

Marion: What did the researchers find with the neuroimaging data?

Bunner: Fractional anisotropy was lower in the concussed group than in the control group both during the acute phase, when they were symptomatic, and after clearance to return to play. Consistent results were seen with mean diffusivity, with significant increases in MD in the concussed group at both time points in the same brain regions.

Marion: In plain English, tell us how these parameters relate to axonal integrity and then brain pathology?

Bunner: The concussed athletes showed evidence of edema and axonal injury. The fact that the DTI parameters did not significantly change between acute concussion and return to play, tells us two things: one, that symptom recovery does not equal brain healing, and two, that these athletes are returning to potentially risky sports activities before full brain recovery.

Marion: Fractional anisotropy, or FA, you can correlate that then with axonal integrity or is that an indicator or marker of axonal damage? Would that be fair?

Bunner: Exactly. Fractional anisotropy directly measures whether water diffuses in a straight line or in many different directions as it is wont to do without constraint. And an axon, being a tube-like structure, if the tube is intact, the diffusion of water will be constrained by the axon. But if the axon is swollen or damaged in some way that will alter the way the water diffuses.

Marion: Thanks Anne. That helps a lot. What are the limitations of this study?

Bunner: We don't have pre-injury neuroimaging data, so we don't know how many of this microstructural changes existed prior to injury. We also know very little about how these small changes observed with these sophisticated neuroimaging techniques impact behavioral and functional outcomes.

Marion: This is the six million dollar question. Is it fair to say that the brain often is not healed and we let these athletes return to play?

Bunner: I think this is exactly what this data suggests, yes. We do need more research to understand how these neuroimaging parameters change during concussion recovery, and over the life span of a person who sustains multiple concussions.

Marion: What is your take away from all this? Are we supposed to ban all contact sports?

Bunner: We know that athletes who sustain a second concussion before their symptoms resolve end up with more severe symptoms and a longer recovery time. Something similar might happen here. I think it's premature to change our recommendations for return to play. We might want to air on the side of

caution. These data highlight a dilemma for providers who have to make recommendations based on limited information.

Marion: Thank you so much, Anne. That was really informative. Unfortunately, that's all we have time for. We hope you enjoyed this quick literature update.

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CUBIST is produced and edited by Deborah Bailin and was hosted today by me, Don Marion. It is a product of the Defense And Veteran's Brain Injury Center, led by acting national director Dr. Thomas Degraba, and the Defense Centers Of Excellence For Psychological Health And Traumatic Brain Injury, led by acting director Dr. Richard Stoltz.

Thank you for listening. We'll be back in two weeks to explore recent concussion literature.