

- S1 00:00 Hi. This is Tim Lightfoot, the director of the Huffines Institute for Sports Medicine and Human Performance. I am so excited to let you know that the Huffines Institute now has apps for your smart phones and your tablets. We have apps for the Apple products and for Android products. You can go to iTunes or go to Google Play, either one, download those Huffines apps and you can pull in our content every week. Now on to the podcast.
- S2 00:26 Welcome to the Sports Medicine podcast brought to you by the Sydney and J.L. Huffines Institute for Sports Medicine and Human performance in the Department of Health and Kinesiology at Texas A&M University. At the Huffines Institute, we're always working to facilitate, apply, and bring you the most up to date coverage of the wide world that is sports medicine and human performance all in a language you can understand and share with your friends. And now, here's our host, the director of the Huffines Institute, Dr. Tim Lightfoot.
- S1 00:56 Our next speaker, we are absolutely thrilled to have him with us in College Station. You've read his bio. He is the only sports medicine individual to ever win a MacArthur Fellowship. This is one of those awards where they walk in the door in your office, and you don't know they're coming, and they give you this really, really big check and say, "You're doing so great. Please go and do some more." And it really is a true honor that no one quite knows how anybody is nominated for this. We're really pleased to have our next speaker with us. One of the leaders in concussion research, Dr. Kevin Gusckiewicz from the University of North Carolina Chapel Hill. Give him a warm welcome. [applause]
- S3 01:32 Thanks, Tim. Thank you. It's a pleasure to be here in College Station. I want to thank Tim and the Huffines Institute for this honor. Sport concussion, it's all over the news. It's rare to pick up a newspaper, watch ESPN, watch the nightly news in a given week without hearing something about this topic of sport concussion. I've been very fortunate at the University of North Carolina Chapel Hill to be studying this for the past 20 years, and I think we're helping to advance the science on this topic. The word "concuss" simply means "to shake violently", and as you can see here, in one plane the head being impacted and the brain shaking violently within the cranial cavity. When this occurs, we see about 86 to 100 billion neurons that the adult human brain houses will do something like this. It distorts upon impact, it stretches, and the axon that sits in the center there can swell. And if it swells and is not treated properly, managed properly, it can in fact disintegrate and we lose that pathway. Many athletes will say, "Well, I've got 86 billion of these. Plenty more to go around. I'm going to continue to fight through this." The work that we conduct is really around trying to prevent this sort of disintegration of a series of neurons and to try to better manage this injury, but you can see the axon sort of disintegrating there. But upwards of four million sport-related concussions occur annually. This is an estimate from the CDC. And I'll tell you - and I'm going to talk more about this more towards the end of my talk - there are no more concussions occurring on our playing fields today than there was 15 or 20 years ago. Despite the fact that we hear so much about it and there's this increased concern about this, there are no more concussions occurring today than there was 15 or 20 years ago. The good news is that we know more about it. The

media has done a pretty good job of helping to educate-- there are 50 states. All 50 states now have a concussion law that emphasizes the importance of education around concussion, and the diagnosis and management of it. So they're showing up more often in emergency departments to be evaluated, which would suggest that there are more occurring, but there in fact are not.

S3 04:02

This is a topic that's been all over the news, as I've already said. It actually made this list of the 10 Ideas That Changed the World in 2012. A friend of mine sent me this and this was the first idea that changed the world in 2012, and I was like, "Why is he sending me this? This is about the US drone system." But I had to only flip down to the fourth item, the fourth idea, and it was this one - football players beware, concussions can be deadly. Just to show you the-- to put in perspective the level of which this topic has reached. Very common to see headlines, as I've already mentioned, such as these. Note that there are an awful lot of positive things occurring around this topic of sport concussion that oftentimes don't make headlines because negative headlines sell newspapers. That's the industry. So oftentimes, we'll read these. Everybody has an opinion on this. President Obama weighed in this two days before the Super Bowl last year, and as you can read there, said that if he had sons that he'd have to think long and hard before allowing them to play football. Tony Boselli, who had a long career with the Jacksonville Jaguars, had an interesting comeback to President Obama, saying that he does have two sons, both who have played football. And he'd have to think long and hard before he'd allow them to get involved in politics. That was Tony's response to this.

S3 05:31

One of the challenges is that we can't see this injury. It's been described as a hidden injury. There are new technologies that are available. Diffusion tensor imaging, which looks at the white matter tracts and the connectivity of white matter tracts. This is an evolving modality that we're really hoping might be able to help us see this injury on imaging. To date, it's called a functional-- we describe it as a functional injury. One that we have to measure the symptomatology, the cognitive function, the array of symptoms that accompany this injury, and changes with balance, which is an area we do a lot of work in. I hope that these technologies will at some point allow us to look at this and to use the DTI - diffusion tensor imaging - and susceptibility weighted imaging as a way to evaluate this.

S3 06:27

So what is all this news? What does all the concern, and in some cases, the paranoia that's been created around this topic mean for this population, these young kids who love to play sport? I have three boys and a daughter. All three boys have played the sport of football, ice hockey, these contact sports. Soccer, there's even a lot of concern around the sport of soccer today, and the risks of concussion and the long term affects with repetitive heading of a soccer ball. This is why Jason Mihalik - my colleague here who coaches youth hockey - it's why Jason, much like myself, I coach youth football. We leave our lab many afternoons, and head out to the practice fields to try to help improve safety in sport, and try to help coaches think about how to better teach techniques and remove the head, if you will, from the game, and minimize the number of head contacts but keep kids physically active.

S3 07:30

Why do I think this is so important? If you go back to 1996, when the surgeon general put out his report on physical activity and health, in 1996 we were sort of at the peak of the childhood obesity and diabetes epidemic, where we had seen these staggering numbers. Even these statistics here, taken just from two or three years ago suggest that we certainly are not-- while we've seen some improvement, believe it or not, in the last two years, there's still a lot of concern about the inactivity of kids. This report,

which really pushed to sort of put kids more-- putting them into physical activity, increasing recreational opportunities for kids in organized sport. One of the concerns with this was the increased risk for injury and how do we manage that injury risk to try to keep kids physically active and promoting physical activity while keeping in check this imbalance, this risk of injury. And so, this is one of the areas that our center at UNC is really focused on, not just looking at managing concussion, preventing concussion, but also looking at musculoskeletal injury. We have colleagues that are working in this area as well.

S3 08:48

This is a piece that Steve Marshall and I published back in 2003, where the sort of take home message, highlighted here in red, was really that the athletic training, sports medicine community really needed to shoulder the burden of trying to increase physical activity and really focus more on the prevention side of the concussion equation. For many years, we've been focusing on developing tools to assess concussion and we validated and put in the hands of clinicians. But there has been a little done in the area of prevention, on the left side of the concussion equation. That's what I want to talk about.

S3 09:28

I wanted to say why I think this is so important that we not just pull kids from physical activity-- are we going to see those numbers climbing again. I love this quote from Kent Farley from the US Sports Academy that really talks about sport so being important for teaching the sort of values of practice and personal development. How, through sport, we learn how important practice is and how we can work on correcting errors. And probably no better depiction of this than this. I love this picture of a youth hockey player. Fall, get up, fall, get up, fall, get up, and learning how to recover from our mistakes. I want to just say that I am concerned about concussions. I don't want to make it sound like we have to go, go, go, and just keep kids in this activity. It's about prevention. Our group published two very important papers back in 2005 and 2007 that looked at the increased risk of depression in former NFL players once they had sustained three or more concussions during their playing career, and likewise the increased risk of developing mild cognitive impairment at a relatively younger age - average age of 55 - in former players with a history of three or more concussions in their professional playing career. We really have looked at this and what the long term concerns are with regard sports concussion and repetitive concussion. A paper that we haven't reviewed right now, though I think will help to advance the science in this area a bit further, this is looking at functional imaging, not too different from what John had shown earlier. And what we found is that former NFL players, compared to former college players, that it had little to do with the exposure or the added years, eight additional years of having played contact sport of football for the NFL cohort at age 55, roughly - average age of 55 - compared to their college only comparison group. Where we see this hyperactivity on functional imaging had to do with those with a history of three or more concussions. It had little to do, as you can see, with those that played for eight additional years. The added exposure, I'm not convinced, is what contributes. And so, these sub-concussive impacts is what contributes ultimately to these changes.

S3 11:59

I'm going to take the last part of my talk here and I'm going to get up on my soap box and say a few things that I think are important to recognize on this topic. Look at the number of peer reviewed publications on this topic just since 2010 relative to the five decades combined leading up to 2010. There's been a tremendous amount of research on this. But what you won't see that show up in this bar graph here from 2010 on, or even 2000 on, there are no studies that really say that there's a specific age by which we should prevent a kid from playing a contact sport. There's very little

there with respect to prospective studies. There's nothing actually with respect to prospective on the cause and effect of these neurodegenerative changes such as CTE. There's certainly associations that have been identified. We need to do a better job with more longitudinal, prospective studies.

S3 13:00

Some of the areas that we're working on to try to focus on that left hand side of the concussion equation is to really work on training and skill development, working with coaches, athletes. I want to emphasize this is not just a football injury. We see concussions in just about every sport. I often tell people about the cross-country runner that I had in my second year at Carolina. He was hit by a deer on the cross-country course and sustained a concussion. The local Elk's Club gave him an honorary membership. We have to recognize that concussions occur in all sports. That was sort of a rare event. Skill, practice, on-field exposure, teaching kids at the right age how to do this. If we just pull kids and put pads on them for the first time at age 16-- some people have suggested, let's not allow kids to play contact sport until the age of 15. My fear is that if for the first time you put a kid in pads, be it football, hockey, lacrosse pads, at that age, I fear we're going to see more catastrophic injuries because the kids aren't going to know how to protect themselves. It's really at about age 11 to 13 if you get into motor learning literature where skill developments-- that critical window, about 10 to 13. Critical window for skill development to learn how to protect yourself. So it's about that, it's about change in the culture.

S3 14:19

We also need to place more emphasis on cervical neck strengthening. We believe this is one of the reasons why women are more susceptible to concussion than men when we compare it in sports where the rules are similar such as soccer. There is a higher incidence of concussion in women's soccer compared to men's soccer, and we think it has to do with, in general, neck musculature. Just to sort of depict this, if you take a blow to the front of the head in the absence of the neck muscles contracting, that small red dot represents the center of mass of the head. You have this large acceleration window. If we change this up and allow the neck muscles to contract, as represented here by the yellow line, we shift the center of mass down more toward the torso. In doing this, we increase the effective mass by about 67% of the neck and the head and we reduce or shrink that acceleration window, as shown here in the dotted line. We need more emphasis on this, and I think it has more to do with the ability to quickly contract the neck musculature than it does global neck strength. We have a study that just came out about four, five months ago, showing this finding.

S3 15:33

And then, finally, putting accelerometers. The technologies that are out there today far exceed what we had even just five years ago. We put accelerometers in the helmets of our youth hockey players and our football players. We have small chips - accelerometers - we can put behind the ear to measure the number of impacts, the location of impacts, and the magnitude of those impacts. We're beginning to teach athletes how to not use their head, how to tackle properly, how not to lead inappropriately with the head. So we're teaching safer sport from inside the helmet.

S3 16:10

To wrap this up, what we think we know: Teaching proper technique and fundamentals at the appropriate age will lead to improved safety. Athletes are safer when coaches, parents, and athletes understand effective concussion recognition and response. Unnecessary contact in youth sports should be limited, and I think many of the youth leagues are beginning to do this. Pop Warner football, USA football have limits on the number of hours of contact per week. But they're still allowing those techniques to be taught, and so there is still tackling and blocking in youth hockey. Teaching how to check appropriately is really important if we're going to try to teach

the kids how to prevent these injuries later on.

- S3 16:51 And what we don't know: Concussion thresholds and why they vary from person to person. I tell people that concussions are like snowflakes. There are no two alike and it's really difficult to say that an impact of 100 Gs is what's going to cause a concussion. Because it might be 100 Gs for one person and it might be 65 Gs for the next person. So we're still trying to advance the science around this. As I've already said, if playing contact sports for any number of years, we don't know how many years, or how many impacts, or how many concussions leads to CTE. We need more evidence to better answer this question. And the specific age of which kids are safe to begin playing, as I've already said, needs to still be further studied.
- S3 17:33 A great study published a few years ago that talked about whether or not the pendulum has swung too far. And I love this line, that Dr. [Duhaine?] talks about. She says that the parents and kids get terrified over the diagnosis of a simple concussion, but historically, most kids with concussions do fine. And then, she goes on to say that our species wouldn't have survived if we didn't. So there's been a bit of-- the topic has been sensationalized in many ways. The pendulum has perhaps swung too far in the direction of concussion phobia, and that we need to think about labeling this as a spectrum. Concussion is not just a single entity and we should think about it as a spectrum, and not something such as diabetes, you have it or you don't. This is along a spectrum.
- S3 18:22 This is our situation room. We don't help the US government and the military better understand who has drones out there, but we have a situation room in our lab right here where we're constantly breaking down film, trying to identify better ways to keep kids safe on the field.
- S3 18:40 In conclusion, the legitimate concern versus paranoia, I think it's a little bit of both. I think that we need to find ways to make sports safer. We do this by identifying predispositions to sport injuries and chronic neurological impairment. We need to teach kids how to modify their behavior, and there are great opportunities to do this through advanced technologies, which is why I think innovative science can, in fact, be a game changer in this topic. And I have to credit my team. We have an amazing team in Chapel Hill, and if you're ever in the neighborhood, please stop by to visit us. Thank you. [applause].
- S1 19:18 Thank you, Kevin. We've got a couple of questions here for you. One from [Yey?] at University of Maryland. I have two kids -one playing football and the other playing soccer. The protective gear they wear does not seem to be helpful despite a lot of technical advancements for the last decade. What would you suggest to prevent or reduce the chance of getting concussion in kids?
- S3 19:39 Great question. What we know is that there is no concussion-proof helmet. That shaking head that I had shown you. I have another slot I could have shown that actually puts a helmet on it, and it does show it slowing or mitigating to some extent the movement of the brain inside the skull. But it's impossible to totally manage the energy there. While I think there are materials out there that are good at helping to prevent scalp fractures and these real high-velocity impacts that would prevent a brain bleed, it's going to have to be a combination of good equipment as well as these prevention techniques, and good coaching and technique, and rule changes. We changed the kick-off rules, as an example, in the NFL and the NCAA to minimize the number of impacts by moving the kick-off line up five yards, and we've reduced concussions by about 40-50% with just one rule change. So it's going to take rule

changes.

- S1 20:34 I have another question here. Is it just the concussions that are causing CTE or are there other factors in contact sports? And what about people who get concussions in other ways? Can they also get CTE?
- S3 20:47 I think the evidence on CTE, the work that's being done at places such as Boston University with Dr. McKee is very important. She did a great job today, I think, of elaborating on this notion that we don't have good prospective studies, but we do believe that it's due to trauma, that tau deposition is due to trauma. But what we don't know is what the dose response is. And so, there are a number of studies that are showing that military folks-- blast injury, which is different from concussion. I have a colleague that has found this in airplane pilots who-- vibrations from after years and years of flying causes similar tau deposits. I don't think this is just a sport injury, but it's an easy one to look at given the number of head contacts, both concussive and sub-concussive, that occur in sports such as football and hockey.
- S1 21:44 I was gonna say you're pretty on the fence-- I'm not saying on the fence-- in the middle on some of this, and so I'm going to ask you to go one way or the other. Do you think it's more important limiting the number of sub-concussive hits or the number of concussions overall?
- S3 21:59 Our research right now in the paper that I hope will be published soon suggests that it has more to do with diagnosed concussions, and I believe that. I believe that there is a-- neurophysiologically, there is a significant difference between a diagnosed concussion with symptomatology that has caused the injury and the way it presents. I think that is very different from sub-concussive impacts. I'm not convinced that a thousand impacts in a year compounded over some period of time is ultimately going to be worse than five diagnosed concussions that we know leads to and is associated with depression. So that's my stance today, but again that's why we do this work. If we knew all of the answers, I'd be out of a job [chuckles].
- S1 22:48 Thank you, Kevin, so much. And please join me in thanking Kevin. [applause]
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