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Physics Report- Major

10/23/22

The article I am choosing to do my report on is titled "Non-contact ACL Injuries: Mechanisms and Risk Factors." This article talks specifically about injuries to the anterior cruciate ligament (ACL). It discusses the idea that physics is not only used to figure out how athletes are acquiring these terrible injuries but how it can be used to prevent them in the future. I am an exercise science major with hopes of becoming a physical therapist after college. My dream job would be to work with athletes and help them recover from injuries they have suffered during competition. ACL injuries are very common among basketball and football players due to the enormous amount of stress and force applied to their lower legs. If I were to work as a physical therapist for a sports team, I would encounter these injuries on a regular basis.

ACL injuries can be caused by a numerous amount of risk factors. Some of these factors include joint laxity, knee recurvatum or hyperextension, increased posterior tibial slope, ACL size or even your gender. However, the most common cause for ACL injury has to be the different forces applied on your lower leg during movements such as jumping, decelerating, changing direction and stopping. The first force talked about in this article is the quadriceps forces. The quadricep muscle is one of the main producers of anterior knee force when the knee is at full extension. A study was done on 11 cavenders to see how much of an impact quadricep force has on the rupture of the ACL. After the study was concluded, the results showed that as a force of 4,500N was applied to the ACL as a quadricep force, 6 out of 11 of the ACL's had completely ruptured. Another important factor that goes along with quadricep force on the ACL

is the knee angle along with the angle of the compressive vector and the anterior shear vector of the quadricep at time of impact. When the knee is at an angle lower than 45 degrees, the compressive vector will be larger than the anterior shear vector. The next important force on the ACL that the article talks about is Axial/Compressive forces on the tibiofemoral joint. A study was done to show how excessive joint compressive loads and internal torque can lead to complete ACL failure. The study showed peak compression ranging from 2,900N to 7,800N would lead to failure of the ACL. A similar study was done that showed how an even l force of 1,812N to 2,659N can lead to the complete rupture of an ACL. The last forces the article talks about are ground reaction forces (GRF) being absorbed by lower leg areas such as hip, knee, ankle, and foot. When performing actions such as jumping or decelerating, these lower leg areas are supposed to help absorb the forces on your knees and hips. In the article they do a good job of comparing how your lower body controls the GRF. The article explains how when you crash your car, the airbag deploys to slow down to slow the time of impact and lower forces on the driver. Similarly, the gastrocnemius-soleus complex slows the speed of the GRFs travel to the knee at times of impact. In the article, it is also stated that when an individual jumps and lands on one leg, their GRF is estimated to range from 2 to 18 times their body weight. On average, the threshold for a torn ACL is about 2,160N and for an individual weighing 70kg, the body must absorb about 3,340N of force when landing on one leg. This example shows you just how important your lower leg is when absorbing these GRF forces.

Besides all the forces applied on your ACL, the next most prominent cause for ACL injuries has to do with the angle of your foot, knee and hip when coming in contact with the ground. When athletes land on their hindfoot or flatfoot (~7 degrees), they are more likely to injure their ACL compared to if they were to land on their forefoot (~23 degrees). Another factor

to take into account is the angle of the tibial plateau. When the tibial plateau is not parallel to the ground at time of impact, there is an increased chance of injuring your ACL.

Before reading this article, I didn't realize how important physics is in my major. The fact that people use factors like forces and vector angles to figure out how ACL injuries take place and how we can try and prevent them really opened my eyes to its relevance.

Source:

Boden, Barry P, et al. "Noncontact Anterior Cruciate Ligament Injuries: Mechanisms and Risk Factors." *The Journal of the American Academy of Orthopaedic Surgeons*, U.S. National Library of Medicine, Sept. 2010, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3625971/.

I spoke to you after class about using this as a source even though it isn't from this year

outstanding
5.5/5