

## Researcher uses MRI to measure joint's geometry and role in severe knee injury

September 23 2014, by Jennifer Nachbur

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The successful rise and fall of an athlete's moving body relies on an orchestrated response of bones, joints, ligaments and tendons, putting the many angles and intersecting planes – literally the geometry – of a critical part like a knee joint to the test. But it's more than just a footfall error at the root of one of the most devastating of sports injuries: the ACL or anterior cruciate ligament tear. In fact, size – of the femoral notch that sits at the center of the knee joint – and volume of the ACL combine to influence the risk of suffering a noncontact ACL injury. Additional geometric characteristics of the knee, such as the slope of the articular surfaces, are involved with risk of injury.

Several recent studies – including a highly-controlled study of first-time ACL injuries in Vermont [high school](#) and college athletic team members – conducted by University of Vermont McClure Professor of Musculoskeletal Research Bruce Beynnon, Ph.D., and colleagues have examined multiple factors like the size of the femoral notch to try and explain why some people are at greater risk for injury than others. With only 200,000 to 300,000 injuries per year, ACL injuries are far less common than ankle ligament injuries, which number more than two million injuries annually. However, ACL injuries can end sports careers and are proven to lead to the early onset of osteoarthritis.

"It's a concern because its highly likely that an individual that suffers this injury will progress to end-stage arthritis in 15 years and the only solution at that point in time – knee joint replacement – only lasts about 15 to 20 years in an active individual," explains Beynnon.

While the rate of ACL injuries across the U.S. haven't changed over time, says Beynnon, he and his team have looked at and continue to research the many variables at play when this injury takes place.

In their August 2014 *American Journal of Sports Medicine* study, titled "Relationship between the risk of suffering a first time noncontact ACL injury and geometry of the femoral notch and ACL: A prospective cohort study with a nested case-control analysis," he and colleagues have "very accurately characterized the incidence rate and magnitude of this problem in Vermont," shares Beynnon.

The researchers examined 88 student athletes – 27 male and 61 female – who suffered first-time, noncontact ACL injuries during the study and compared their measurements – taken using MRI (magnetic resonance imaging) images of their knees – to a non-injured control group of 88 athletes (same male-female breakdown) from the same teams, with the same extrinsic factors, like environment, playing surface, training, footwear, level of competition, and coaching.

These measurements led them to look at the point where the ACL sits in the center of the knee – the femoral notch – where they measured its width, as well as ACL volume using MRI technology in the University of Vermont's MRI Center for Biomedical Imaging. One of the findings they discovered is that the risk of injury increased as the size of the femoral notch and ACL decreases.

"Prognostic studies are designed to identify who is likely to suffer injury so we can target injury prevention programs at them, and determine why they are at increased risk so we can inform the development of the programs to reduce the risk of injury and re-injuries of the same kind," says Beynnon.

In a parallel five-year epidemiological study, also published in the

August 2014 *American Journal of Sports Medicine*, the researchers reported on "The Effects of Level of Competition, Sport, and Sex on the Incidence of First-Time Noncontact Anterior Cruciate Ligament Injury."

From the data they collected from a total of 38 institutions located throughout Vermont,, colleges reported 48 ACL injuries during the sport seasons studied, while high schools reported 53 injuries. The research team learned that college athletes had a significantly higher ACL injury risk than high school athletes – around two-fold – and that female athletes were two times more at risk for ACL injuries than males. In comparison to athletes taking part in Lacrosse, risk of ACL injury was significantly greater among those participating in soccer and rugby. In their conclusion, Beynnon and the study's authors state "An athlete's risk of having a first-time noncontact ACL injury is independently influenced by level of competition, the participant's sex, and type of sport they participate in, and there are no interactions between their effects. Female college athletes have the highest risk of having a first-time noncontact ACL injury among the groups studied."

"The first step is to establish the athletes most at risk; targeting interventions comes second."

He and colleagues are currently conducting a multivariable study that has 109 participants. They are looking at the role of a host of different factors to try to further identify those at increased risk for ACL injury.

"It's not just biomechanics, it's biomechanics and biology," Beynnon says, adding that family history – a genetic link – could be the driver of such variables as problems with ACL collagen synthesis and degradation, joint laxity, exercise and diet, body mass index, and an individual's inflammatory response.

In five to ten years, Beynnon hopes his group can repeat their

epidemiological study to affirm their findings, test the high school and college athlete model on a different, independent sample of individuals, and is considering developing an intervention study

"Primary prevention is the ultimate goal," says Beynnon. "We want to reduce the risk of [injury](#) and burden of disease for this young age group."

**More information:** Darryl C. Whitney, Daniel R. Sturnick, Pamela M. Vacek, Mike J. DeSarno, Mack Gardner-Morse, Timothy W. Tourville, Helen C. Smith, James R. Slauterbeck, Robert J. Johnson, Sandra J. Shultz, Javad Hashemi, and Bruce D. Beynnon. "Relationship Between the Risk of Suffering a First-Time Noncontact ACL Injury and Geometry of the Femoral Notch and ACL: A Prospective Cohort Study With a Nested Case-Control Analysis." *Am J Sports Med* August 2014 42 1796-1805; published online before print May 27, 2014, [DOI: 10.1177/0363546514534182](#)

Bruce D. Beynnon, Pamela M. Vacek, Maira K. Newell, Timothy W. Tourville, Helen C. Smith, Sandra J. Shultz, James R. Slauterbeck, and Robert J. Johnson. "The Effects of Level of Competition, Sport, and Sex on the Incidence of First-Time Noncontact Anterior Cruciate Ligament Injury." *Am J Sports Med* August 2014 42 1806-1812; published online before print July 11, 2014, [DOI: 10.1177/0363546514540862](#)

Provided by University of Vermont

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