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New computer simulation focuses on the role muscles play in pitchers' elbow injuries

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A new approach to analyzing baseball-pitching biomechanics may one day give players more personalized feedback and help prevent elbow injuries.

In a computer simulation study of baseball pitching, Northwestern University biomedical engineers found that the strength of the elbow muscles of a baseball pitcher likely play a bigger role in injury risk and prevention than previously thought.

The motion analysis approach currently used in the baseball industry to provide athletes with injury-risk feedback is not sophisticated enough to estimate what an individual player's muscles are doing during a pitching motion or how his muscles are contributing to injury risk.

"Muscles matter in baseball," said James Buffi, first author of the study. "We showed that a pitcher could be at a really high risk or a really low risk of elbow injury, depending on how strong and capable his muscles are."

Buffi is a recent Ph.D. graduate in biomedical engineering at Northwestern's McCormick School of Engineering and Applied Science.

He conducted the research with senior author Wendy M. Murray, associate professor of biomedical engineering at McCormick. Murray also has joint appointments in the departments of physical medicine and rehabilitation and physical therapy and human movement sciences at

Northwestern University Feinberg School of Medicine.

"Pitching is an extreme and difficult motion," said Murray, who also is a research scientist at the Rehabilitation Institute of Chicago. "Pitchers are literally throwing so hard that the motion itself acts to tear the elbow joint apart. But why doesn't it? The answer is the strength of the muscles and the ligaments. That's what keeps the bones together."

Results of the study are detailed online in the journal *Annals of Biomedical Engineering*.

Many baseball pitchers experience an elbow injury at some point in their career. The most common is failure of the ulnar collateral ligament (UCL), which requires ligament reconstruction known as Tommy John surgery.

To better understand the stress pitching puts on the UCL, the Northwestern researchers used a specific computer model developed from bone, muscle and ligament geometry measurements taken in cadavers, as well as muscle volume and strength measurements taken in living subjects. This is the same model developed and used by the researchers to study arm and hand control for advanced prosthetic devices.

They developed a computer simulation of a real high school pitcher's throwing motion to investigate how individual muscles can affect UCL loading and how changes in muscle output can either relieve or exacerbate the load on the UCL.

"Our simulations illustrate that if the muscles were doing nothing, then the bones that make up the elbow joint could have been pulled apart during that single pitch. In contrast, we also were able to implement

reasonable assumptions about muscle performance that showed how the very same pitch could result in no load on the UCL at all," Murray said.

While this study only looked at one pitcher and one motion, the simulation approach allowed the researchers to repeat the engineering analysis of the mechanics of that pitch while making different assumptions about what complicated muscles and ligaments are doing and how they are working during a pitch.

The researchers evaluated how effectively the muscles countered the dangerous load at the elbow joint during a pitch and used a variety of assumptions to understand how sensitive the simulation results were to muscle strength and other model parameters.

With more research, this approach could enable targeted training of specific muscles and more accurate assessments of UCL vulnerability, Buffi said. He is planning to use this research and further this work in a career in the baseball industry.

"Elbow injuries are a huge problem in baseball, from little to major leagues, and our study shows that muscles play a part," Buffi said. "If you're not accounting for muscles, even if you know the total elbow load on a pitcher, he could be at a really high risk or a really low risk of injury depending on how strong and capable his muscles are."

More information: *Annals of Biomedical Engineering*: link.springer.com/article/10.1 … 07/s10439-014-1144-z

Provided by Northwestern University