Investigating Early Initiation of Trunk Rotation in Baseball Pitchers and its Relationship with Tommy John Surgery

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Abstract

The rate of Tommy John surgery in baseball has exploded since the surgery was first invented in 1974, and especially since the year 2000. Teenage athletes, specifically, have been shown to be at the highest risk for the injury that necessitates Tommy John surgery – a tear in the Ulnar Collateral Ligament. This seems like a recipe for disaster – and in 2020, the epidemic took the life of 20-year-old pitcher Sang Ho Baek, who tragically passed from complications from TJS. Lots of work has been done to uncover potential causes for TJS, and Early Trunk Rotation, or ETR, shows promise as a potential biomechanical factor. However, only one study, and a flawed one at that, has really dug into the issue of ETR and if it impacts TJS, and this premise can easily be expanded upon with further, more detailed analysis. In this proposal, I plan on investigating the relationship between ETR and upper extremity injuries in baseball pitchers. I expect to generate a statistical analysis, and I hope that this analysis will both demonstrate the significance of ETR as a factor in these injuries and serve as a potential pathway to other analyses in the same vein.

Introduction

In 1974, Los Angeles Dodgers team doctor Frank Jobe performed an experimental surgery on a pitcher named Tommy John. Jobe toke a ligament from John's right forearm (as John was a left-handed pitcher) and inserted it in place of his torn UCL in his left elbow. The surgery, the first of its kind, was a success. Tommy John became eponymous with UCL reconstruction surgery, which is now often referred to only as Tommy John surgery, or TJS (Hopkins).

TJS was very uncommon in the early years of its existence. Between 1974 and 1994, the first 20 years after the procedure came into being, a grand total of 12 pitchers in the MLB had the surgery (White, 2018). From 1995-1999, 22 MLB pitchers had TJS. From 2000-2011, that number skyrocketed – 194 surgeries, on MLB pitchers alone (White). That isn't accounting for the minor leagues (where there were 275 surgeries in that time span), or any baseball below the professional level (White). The dramatic increase in the amount of surgeries for MLB players is certainly alarming, but it doesn't really demonstrate the full scope of the issue. The most horrifying factoid is this, from the American Orthopaedic Society for Sports Medicine: 15-19 year olds were the subjects of 56.7% of all UCL reconstruction surgeries in the US between 2007 and 2011, and the rates increased on average at 9.12% per year in that timespan.

In other words, teenage athletes are the demographic most affected by what could only be described as an epidemic, and the rates at which baseball players across all levels undergo TJS are increasing rapidly. And although TJS is considered a low-risk procedure, with the number of surgeries skyrocketing, something terrible was bound to happen eventually, and it did.

Background Research/Motivation

Sang Ho Baek was an immigrant from Seoul, South Korea, a freshman collegiate pitcher at George Mason University (Nesbitt, 2021). As is unfortunately the case more and more

frequently, Sang's elbow started hurting during his freshman year. It turned out that he needed TJS. So he went to a Washington, DC medical center, and underwent a routine UCL reconstruction procedure.

Four days later, Sang Ho Baek passed away from blood clots as a result of his surgery, the first recorded death of such kind. He was only 20 years old.

Sang Ho Baek's tragic story is a harsh reminder that, if nothing changes, pitchers – and, specifically, 15-19 year old kids, the age demographic most impacted by the ongoing epidemic – face potentially severe consequences. The causes for UCL damage in pitchers are still relatively unknown, but if there is a way to help prevent them, it is absolutely imperative that it be discovered and implemented, to minimize the risk of anything like what happened to Sang Ho Baek happening ever again.

If there is a specific cause for UCL tears in pitchers, it's likely that it's biomechanical, at least to some extent. When a baseball pitcher throws, levels of elbow valgus stress can exceed the tested strength of the ligament in cadavers (Boddy, 2010). This can cause fraying of the ligament over time, which can in turn lead to a complete rupture. Thus, if certain mechanical elements of a pitcher's motion can increase valgus stress, they can increase the chances of a UCL injury.

A potential candidate for a biomechanical flaw that can increase elbow valgus is early initiation of trunk rotation in the early cocking phase. The early cocking phase is generally considered to be the point in a pitcher's delivery where the throwing arm travels into a "cocked" position – forearm upright, fingers on top of the ball – before the pitcher's front foot strikes the mound (Douoguih, Dolce, and Lincoln, 2015). Sequentially, most pitchers who utilize an overhead delivery cock their arms, their front foot lands, and then their trunks rotate as they

move to deliver the pitch. In a delivery where ETR is present, rotation of the trunk is initiated before the throwing arm reaches a fully cocked position, which typically also means it occurs before the front foot strikes the mound.

Several different studies pointed to early initiation of trunk rotation as factors caused increase elbow valgus stress. Aguinaldo & Chambers (2009) found that early trunk rotation had a statistically significant relationship with elbow valgus torque in baseball pitchers. Although the study stops short of linking early trunk rotation and injuries, the notion that ETR can increase elbow valgus means that it could potentially be a cause of elbow or other upper extremity injuries. Furthermore, Calcei, Schulman, and Workman (2021) found that premature rotation of the trunk is a risk factor for shoulder injuries. Although shoulder injuries are not necessarily related to UCL injuries, increased stress on the throwing arm in general will result in higher risk for upper extremity injuries, and so even if the study doesn't focus specifically on valgus torque, it's significant.

With that said, if there is a relationship between ETR and upper extremity injuries (like the UCL), it would likely show up in any study of a large enough sample size reviewing pitcher injuries and the mechanics of those involved. Starting in 2011, Washington Nationals team doctor Wiemi Douoguih put this hypothesis to the test. He and his team studied 250 pitchers from the 2010 MLB season, their biomechanics, and their injuries within a 3-year span – and they found a statistically significant relationship between ETR and upper extremity injuries in baseball pitchers (Douoguih, Dolce, and Lincoln).

This study was not perfect. It had a small sample size and a limited time span. The study also didn't do any further grouping in an attempt to remove underlying variables. With that said, it demonstrated a relationship between ETR and upper extremity injuries, so it shows promise for

further research. I intend to fill the gaps that this study missed and produce an answer to the following question: Does the presence of ETR, by itself, lead to increased rates of upper extremity injury in baseball pitchers?

Methods

I propose doing something similar – with a few key fixes. I propose an analysis on every pitcher in the MLB since 2009 who has thrown more than 250 innings since then. I will utilize publicly available video to analyze every pitcher in this sample for early trunk rotation – if their arm is not reaching a cocked position by the time their trunk commences rotation- and then I will work to discover their career injury outcomes. I will work pitcher-by-pitcher to make sure that I get an accurate understanding of the presence for ETR for each. I will analyze at least 5 pitches per inning pitched by a pitcher in an individual game, and no less than 5 games in an individual season (unless, and this is very unlikely, a pitcher in the sample never pitched more than 4 games in a single season). I will also be sure to analyze video from every season within the sample size for each pitcher I study.

In my analysis, I will end up with two groups – pitchers in my sample who demonstrate ETR, and pitchers who do not. I intend to further sort these groups by other variables: total innings pitched, average fastball velocity, age during injury onset, pitchers with previous upper extremity injuries, and more variables which have shown to be factors in TJS (Boddy). This will enable me to understand the exact impact that ETR has on upper extremity injuries, and provide a potential look into what has caused the explosion of TJS. I will then conduct a statistical analysis to determine if there is a statistically significant correlation between ETR and upper extremity injuries, and if any of the other variables that I use to create the sub-groups generate a

correlation as well. I will compare these numbers between groups to provide evidence for or against ETR as a factor in upper extremity injuries.

Expected Results

I expect to generate a statistical analysis comparing pitchers with and without ETR among my entire sample and then split among many different sub-groups. I expect that my analysis will reveal that there is a correlation between ETR and upper extremity injuries, and it will also reveal that variables such as higher fastball velocity and more innings pitched increase this correlation in pitchers with ETR. Ideally, this will serve as a launching-off point for further research into the subject – if, as I expect, ETR is demonstrated as having a statistically significant relationship with upper extremity injury, then it can be used as a variable in further studies of different variables in this exact same manner – i.e. a similar study, but instead of focusing on ETR, focus on pitchers who lack a certain degree of external rotation, and so on.

Conclusion

The Tommy John epidemic has exploded in recent years, with rates surging dramatically since 2000. With my analysis, I hope to further investigate a potential factor in this epidemic and help provide evidence that can help pitching coaches all over the world detect and minimize potentially dangerous mechanical flaws in their pitchers. This work could lead to further studies in a similar vein that, eventually, allow us to generate a complete picture of the causes for Tommy John surgery and dramatically decrease the incidence rate of these injuries. Overall, I hope that I can help reveal a potential factor in the explosion of TJS and help prevent future tragedies from occurring to young pitchers like Sang Ho Baek.

Works Cited/References

Aguinaldo, A. L., & Chambers, H. (2009). Correlation of throwing mechanics with elbow valgus load in adult baseball pitchers. *The American journal of sports medicine*, *37*(10), 2043–2048. https://doi.org/10.1177/0363546509336721

American Orthopaedic Society for Sports Medicine. (2015, July 12). Tommy John surgeries increasing for youth athletes. *ScienceDaily*. Retrieved November 4, 2021 from www.sciencedaily.com/releases/2015/07/150712203819.htm.

Boddy, K (August 27, 2010). *Elbow Injuries and What Causes Tommy John Surgery*. Driveline Baseball. Retrieved November 4, 2021 from http://www.drivelinebaseball.com/2010/08/elbow-injuries-and-what-causes-tommy-john-surgery/. Accessed 4 Nov 2021.

Buffi, J (April 29, 2015). *Why Sir Isaac Newton is Still the Foremost Expert in Pitching Biomechanics*. Driveline Baseball. Retrieved November 4, 2021 from https://www.drivelinebaseball.com/2015/04/why-sir-isaac-newton-is-still-the-foremost-expert-in-pitching-biomechanics/

Calcei, J. G., Schulman, B. L., Workman, W. B. (2021). Pitching Mechanics: Do Certain Mechanics Predispose Pitchers to Shoulder Injuries? *Operative Techniques in Sports Medicine, 29*(1) https://doi.org/10.1016/j.otsm.2021.1e50796.

Douoguih, W. A., Dolce, D. L., & Lincoln, A. E. (2015). Early Cocking Phase Mechanics and Upper Extremity Surgery Risk in Starting Professional Baseball Pitchers. *Orthopaedic Journal of Sports Medicine*. https://doi.org/10.1177/2325967115581594

Luera, M. J., Dowling, B., Magrini, M. A., Muddle, T., Colquhoun, R. J., & Jenkins, N. (2018). Role of Rotational Kinematics in Minimizing Elbow Varus Torques for Professional Versus High School Pitchers. *Orthopaedic journal of sports medicine*, *6*(3), 2325967118760780. https://doi.org/10.1177/2325967118760780

Nesbitt, S. J. '*His name is Sang. He is a pitcher.' A family's American Dream, their unbearable loss*, The Athletic. Retrieved November 4, 2021 from https://theathletic.com/2837568/2021/09/22/his-name-is-sang-he-is-a-pitcher-a-familys-american-dream-their-unbearable-loss/?redirected=1

Reiman, M.P., Walker, M.D., Peters, S, Kilborn, E, Thigpen, C.A., & Garrigues, G.E. (2019). Risk factors for ulnar collateral ligament injury in professional and amateur baseball players: a systematic review with meta-analysis. *Journal of shoulder and elbow surgery*, *28* (1), 186-195, https://doi.org/10.1016/j.jse.2018.08.018.

Tommy John Surgery (Ulnar Collateral Ligament Reconstruction), Johns Hopkins Medicine. Retrieved November 4, 2021 from https://www.hopkinsmedicine.org/health/treatment-tests-and-therapies/tommy-john-surgery-ulnar-collateral-ligament-reconstruction.

Werner, S. L., Murray, T. A., Hawkins, R. J., & Gill, T. J. (2002). Relationship between throwing mechanics and elbow valgus in professional baseball pitchers. *Journal of shoulder and elbow surgery*, *11*(2), 151–155. https://doi.org/10.1067/mse.2002.121481

White, D. W. (March 9, 2018). *The Tommy John Surgery Explosion in the MLB*, Samford University. Retrieved November 4, 2021 from https://www.samford.edu/sports-analytics/fans/2018/The-Tommy-John-Surgery-Explosion-in-the-MLB.

Budget

Materials:

Because I will be analyzing a lot of video frame-by-frame, I will need a computer capable of handling high-speed video software with lots of storage space. A newer iMac will suffice. All video I will be using is freely available on YouTube.

Hourly Pay:

The LMU rate for undergrad research is $15 an hour. With over 600 pitchers in my sample, and the detail it will take to analyze each, I estimate it will take no less than 200 hours of video analysis followed by 15 hours of research and statistical analysis to complete this study.

Total Cost:

2019 iMac ($669.99 at https://www.amazon.com/Apple-inches-I3-8100-MHK23LL-Renewed/dp/B08RJS9W92/ref=sr_1_14?keywords=iMac&qid=1639363539&s=electronics&sr=1-14)

215 hours * $15 per hour = $3,225

Overall cost= $3,894.99

Timeline

Week 1:

-30 hours of frame-by-frame video analysis on pitchers from selected sample

Week 2:

-30 hours of frame-by-frame video analysis on pitchers from selected sample

Week 3:

-30 hours of frame-by-frame video analysis on pitchers from selected sample

Week 4:

-30 hours of frame-by-frame video analysis on pitchers from selected sample

Week 5:

-30 hours of frame-by-frame video analysis on pitchers from selected sample

Week 6:

-30 hours of frame-by-frame video analysis on pitchers from selected sample

Week 7:

-20 hours of frame-by-frame video analysis on pitchers from selected sample

-15 hours of research and statistical analysis, finalize results of analytical study