Eminence-Based Medicine Versus Evidence-Based Medicine: It's Okay for 12-Year-Old Pitchers to Throw Curveballs; It's the Pitch Count That Matters

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Fotios P. Tjoumakaris, MD[1]
Matthew D. Pepe, MD[1]
Joseph Bernstein, MD[2]

[1]Jefferson Medical College, Philadelphia, PA; [2]University of Pennsylvania School of Medicine, Philadelphia, PA

Abstract: Working from a prior investigation, we sought to determine the validity of the claim: "It's okay for 12-year-old pitchers to throw curveballs; it's the pitch count that matters." Our previous expert opinion survey demonstrated that this statement was most probably false. The purpose of this report was to investigate the validity of this statement, and to determine if our sports medicine experts "got it right." Using the most current sports medicine literature, this statement was critically examined so that an evidence-based opinion could be given and compared with the results of our prior study.

Keywords: pitching; curveball; pitch count; little league elbow; little league shoulder

Introduction

We previously surveyed 500 experts in sports medicine and presented various statements regarding issues in sports medicine for which the literature does not provide definitive guidance.[1] Respondents were asked to state agreement or disagreement with the given statements according to a 7-point, centered, symmetrical scale:

1. "The statement is false."
2. "The statement is very likely to be false."
3. "The statement is probably false."
4. "The statement may be true/false; 50–50."
5. "The statement is probably true."
6. "The statement is very likely to be true."
7. "The statement is true."

When presented with the statement, "It's okay for 12-year-old pitchers to throw curveballs; it's the pitch count that matters," the mean score was 2.9, which is very close to "The statement is probably false." The responses to the statement followed the distribution in Table 1.

The purpose of this commentary is to review the fundamental issues implicit in the statement regarding 12-year-old boys throwing curveballs, to share what the literature has to say, and to attempt to interpret the experts' responses in context.

The Question

Throwing is a supraphysiologic event. When throwing, the glenohumeral and elbow joints are taken through a wide range of motion, with great accelerating and decelerating

Correspondence: Joseph Bernstein, MD, Philadelphia Veterans Hospital, University of Pennsylvania, Department of Orthopaedic Surgery, 424 Stemmler Hall, Philadelphia, PA 19104.
Tel: 215-349-8833
Fax: 215-754-4214
E-mail: orthodoc@uphs.upenn.edu

Table 1. Statistical Breakdown of Responses to the Curveball Statement

Statement	Group mean	Orthopedic Surgeon mean	Nonsurgeon mean	"The statement is false." (%)	"The statement is very likely to be false." (%)	"The statement is probably false." (%)	"The statement may be true/false; 50–50." (%)	"The statement is probably true." (%)	"The statement is very likely to be true." (%)	"The statement is true." (%)
It's okay for 12-year-old pitchers to throw curveballs; it's the pitch count that matters	2.9	3.6	2.7	36	19	9	7	13	9	5

forces applied on them. There is higher strain in baseball throwing than in other sports (eg, golfing, volleyball, and football).[2] This is because a baseball has seams, which encourages the pitcher to try to impart a spin on the ball and create Bernoulli forces that deflect the normal path of the thrown ball and "curve" its trajectory. Generating this spin requires the pitcher to place even greater-than-ordinary forces on the forearm.

The controversy behind children throwing curveballs is that with open growth plates, the child is at greater risk for injury. The counter argument—one not necessarily advocating curveball pitching but staking a more permissive posture—is that far greater damage can be inflicted by simple overuse, and that the most effective way to limit injury is to simply limit the number of throws. With such a limit, the argument goes, judicious employment of the occasional curveball is no more apt to injure the musculoskeletal system than an occasional French fry will damage the metabolic system.

The Literature

It is well established that overuse injuries occur in children and adolescents. The concept of "little league shoulder" and "little league elbow" represent a spectrum of injury that occurs in response to repetitive throwing motions that are commonly encountered in baseball.[3–5] In the presence of open physes, significant strain is transmitted to the proximal humeral physis and the medial epicondylar apophysis during the late-cocking and acceleration phases of the baseball pitch. After closure of the physes, this force is then transferred to the soft tissue stabilizers of the shoulder (ie, rotator cuff and labrum) and elbow (ie, ulnar collateral ligament).

A generalized approach to prevent injury that could compromise a young adult's athletic career is perhaps more important than devising a perfect approach for treating the malady once it arises. Current strategies in youth baseball are aimed at limiting the number and type of pitches that are thrown. This is commonly done through the enforcement of pitch counts and avoidance of curveballs (and related spin-dependent pitches). The degree to which enforcement of these guidelines are carried out is currently unknown. In addition, the evidence supporting these guidelines may not be widely known by sports medicine physicians.

When evaluating studies that attempt to answer the questions of pitch count and type and their relation to injury, it is clear that the majority of these investigations, by nature of the question being asked, are observational, not experimental. Nevertheless, useful information can be gleaned. In a study evaluating the pitching mechanics of youth pitchers and relating mechanics to injury, the authors found that pitchers with better mechanics produced decreased humeral internal rotation torque, lower valgus load, and more efficiency than those with poor biomechanics.[6] This study is one of the first to implicate the biomechanics of the pitch and its importance in reducing force generation, and perhaps injury, in youth players.

Other studies have shown differences in youth pitchers that may predispose them to injury; however, these studies have not demonstrated causation.[7,8] In a prospective cohort study that sought to answer both questions, the authors looked for an association among pitch count, pitch type, and the mechanics of throwing with shoulder and elbow pain in youth pitchers. In this study, subjects were followed for 1 season. The curveball was associated with a 52% increase in shoulder pain, and the slider (another spin-dependent pitch) was associated with an 86% increase in elbow pain in these athletes. There was also a significant association between

number of pitches thrown (as counted both in a single game and over the course of the season) and the development of shoulder and elbow pain; however, there was no significant association found between mechanics and the development of pain in this study.[9]

In a 10-year prospective study of youth baseball, Fleisig et al[10] attempted to answer both questions (ie, pitch count and type) by studying 481 youth pitchers. They found that pitchers who threw > 100 innings per year were 3.5 times more likely to be injured (using stringent injury criteria), and that beginning to throw a curveball prior to age 13 years had no effect on the rate of injury.

In a case-control study attempting to assess risk factors for shoulder and elbow injury in adolescents, the authors found a positive correlation among number of pitches thrown, frequency of pitching, and fatigue; however, the type of pitch and age at which other pitches were introduced demonstrated no correlation with injury.[11] Petty et al[12] found a weak association between overuse and early introduction of breaking-speed pitches in high school baseball players who underwent ulnar collateral ligament reconstruction.

Investigators evaluating the biomechanics employed by youth pitchers throwing 3 types of pitches (ie, fastball, curveball, and change-up) attempted to determine whether a curveball is more dangerous to throw (with regard to peak force and torque) than the other 2 types of pitches. They found that the fastball produced the greatest values for elbow varus torque, shoulder internal rotation torque, elbow proximal force, and shoulder proximal force, with the curveball and change-up coming in second and third, respectively.[13] These findings confirmed those that were found in a prior study examining collegiate pitchers, which demonstrated lower joint kinetics and angular velocities with the change-up relative to the fastball and curveball.[14] In a more recent report from different investigators, the curveball was again shown to have less force generation than the fastball for both the shoulder and elbow in adolescent baseball pitchers.[15]

After review of the data, it is clear from low-evidence studies that overuse and excessive pitching are clearly associated with injury in youth baseball. What is less clear, however, is the role, if any, that curveballs and other spin-dependent pitches play in creation of this injury. No clear associations exist to support this claim in the orthopedic literature; however, current guidelines from Little League Baseball do not recommend allowing young athletes to pitch curveballs before age 14 years (± 2 years).[4] Current guidelines exist for pitch counts in youth baseball as well, with the recommendation that any athlete aged ≤ 10 years be limited to 75 pitches per day, with 3 rest days for any days in which ≥ 61 pitches are thrown. Pitch count allowance can be increased by intervals of 10 based on age bracket (ie, 11–12, 13–16, and 17–18 years limited to 85, 95, and 105 pitches per day, respectively), with the pitch threshold for 3 days' rest increased to ≥ 76 pitches for players aged 17 to 18 years.[3]

The Experts

As shown in Table 1, the mean response trended toward declaring the statement to be false (mean, 2.9). The option "The statement is false" garnered a plurality of voters at 36%. When the mean of the responses was recorded as ≤ 3.0, a consensus that the statement was false was deemed to have been reached.[1] With regard to curveballs being inappropriate in youth sports, nonoperative sports medicine specialists were more likely to recommend against curveball pitching in this instance (mean, 2.7). Orthopedic surgeons were not as convinced as their nonoperative colleagues that this statement was false; however, they did err on the side of recommending against curveball pitching as well, based on the response (mean, 3.6). We were also very close to having a "disagreement" between orthopedic and nonorthopedic sports medicine specialists based on a score difference of ≥ 1.0. Although the response difference did not fall within the "disagreement" threshold, there was some difference of opinion. Interestingly, there was not a significant controversy with regard to this topic because most respondents believed the statement to be on the false side of the decision-making spectrum.

Did the experts "get it right?" From our review of the literature, if we were to apply a strict evidence-based guideline, the answer would be probably not. Evidence shows that pitch count is a more important factor in causing elbow or shoulder injuries in the developing athlete than curveballs.[11] That being said, the evidence in the literature is not level I evidence, and thus strict guidelines cannot currently be established. So, "getting it right" in this instance would have most likely resulted in controversy, which would have split people almost evenly between "probably true" and "true," and "probably false" and "false." In this instance, with a lack of good data to support a strong conclusion, one can understand why clinicians would recommend against both high pitch counts and throwing curveballs for youth pitchers. Because the current recommendation among youth sports leaders is to delay curveball and slider pitching until near skeletal maturity, we find no fault with the results of our survey in this regard.

Future Research

The question as to whether children and adolescents should be allowed to throw curveballs might be resolved with a well-designed randomized controlled trial, as long as care is taken to explicitly ensure that all of the pitchers are of the same bone age (12-year-olds may have a skeletal age ranging from 10 to 14, depending on the onset of puberty),[16] and that all confounding factors (eg, activity level, throwing history, and compliance with the assigned regimen) are controlled. Yet, even with definitive results from such research in hand, it is quite possible that many coaches and parents will aim for a more conservative approach—and not allow curveball throwing—noting that there is no particular advantage (aside from, perhaps, winning a game) to begin throwing curveballs at age 12 years, as opposed to deferring to a later age; that is, if a pitcher can become a good curveball thrower, even if his or her first curveball were thrown at age 16 years or later, prudence may argue for a later start in life for at least this particular activity.

Conclusion

The expert panel was not in favor of allowing 12-year-olds to throw curveballs. This position can be justified on the basis of caution and logic. The literature, although not definitive in this regard, provides little evidence to support this contention, unless one considers the current guidelines of Little League Baseball. Perhaps the most important takeaway point is that there should be great attention paid to all young athletes, not just pitchers, with regard to possible overuse injuries. Although it is certainly theoretically possible that throwing curveballs may be harmful, it is clear that overuse is certainly not healthy.

Conflict of Interest Statement

Fotios P. Tjoumakaris, MD, Matthew D. Pepe, MD, and Joseph Bernstein, MD disclose no conflicts of interest.

References

1. Tjoumakaris FP, Ganley TG, Kapur R, Kelly J, Sennett B, Bernstein J. Eminence based medicine versus evidence based medicine: level V evidence in sports medicine. *Phys Sports Med*. 2011;39(4):124–130.
2. Escamilla RF, Andrews JR. Shoulder muscle recruitment patterns and related biomechanics during upper extremity sports. *Sports Med*. 2009;39(7):569–590.
3. Kocher MS, Waters PM, Micheli LJ. Upper extremity injuries in the paediatric athlete. *Sports Med*. 2000;30(2):117–135.
4. Taylor DC, Krasinski KL. Adolescent shoulder injuries: consensus and controversies. *J Bone Joint Surg Am*. 2009;91(2):462–473.
5. Stein CJ, Micheli LJ. Overuse injuries in youth sports. *Phys Sports Med*. 2010;38(2):102–108.
6. Davis JT, Limpisvasti O, Fluhme D, et al. The effect of pitching biomechanics on the upper extremity in youth and adolescent baseball pitchers. *Am J Sports Med*. 2009;37(8):1484–1491.
7. Sabick MB, Torry MR, Lawton RL, Hawkins RJ. Valgus torque in youth baseball pitchers: a biomechanical study. *J Shoulder Elbow Surg*. 2004;13(3):349–355.
8. Keeley DW, Hackett T, Keirns M, Sabick MB, Torry MR. A biomechanical analysis of youth pitching mechanics. *J Pediatr Orthop*. 2008; 28(4):452–459.
9. Lyman S, Fleisig GS, Andrews JR, Osinski ED. Effect of pitch type, pitch count, and pitching mechanics on risk of elbow and shoulder pain in youth baseball pitchers. *Am J Sports Med*. 2002;30(4):463–468.
10. Fleisig GS, Andrews JR, Cutter GR, et al. Risk of serious injury for young baseball pitchers: a 10-year prospective study. *Am J Sports Med*. 2011;39(2):253–257.
11. Olsen SJ, Fleisig GS, Dun S, Loftice J, Andrews JR. Risk factors for shoulder and elbow injuries in adolescent baseball pitchers. *Am J Sports Med*. 2006;34(6):905–912.
12. Petty DH, Andrews JR, Fleisig GS, Cain EL. Ulnar collateral ligament reconstruction in high school baseball players: clinical results and injury risk factors. *Am J Sports Med*. 2004;32(5):1158–1164.
13. Dun S, Loftice J, Fleisig GS, Kingsley D, Andrews JR. A biomechanical comparison of youth baseball pitches: is the curveball potentially harmful? *Am J Sports Med*. 2008;36(4):686–692.
14. Fleisig GS, Kingsley DS, Loftice JW, et al. Kinetic comparison among the fastball, curveball, change-up, and and slider in collegiate baseball pitchers. *Am J Sports Med*. 2006;34(3):423–430.
15. Nissen CW, Westwell M, Ounpuu S, Patel M, Solomito M, Tate J. A biomechanical comparison of the fastball and curveball in adolescent baseball pitchers. *Am J Sports Med*. 2009;37(8):1492–1498.
16. Dimeglio A, Charles YP, Daures JP, de Rosa V, Kaboré B. Accuracy of the Sauvegrain method in determining skeletal age during puberty. *J Bone Joint Surg Am*. 2005;87(8):1689–1696.

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