Biomechanical Comparisons Among Fastball, Slider, Curveball, and Changeup Pitch Types and Between Balls and Strikes in Professional Baseball Pitchers

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Article information

Abstract

Background:

In professional baseball pitchers, pitching biomechanics have not been examined for the slider, and the only known study for the curveball and changeup examined limited kinetics. Moreover, no known studies have investigated pitching biomechanics between strikes and balls.

Purpose/Hypothesis:

The purpose was to compare pitching biomechanics in professional baseball pitchers among the fastball, slider, curveball, and changeup and between balls and strikes. It was hypothesized that pitching kinematics and kinetics would be similar among the slider, fastball, and curveball; shoulder and elbow forces and torques would be significantly lower in the changeup; and pitching biomechanics would be similar between balls and strikes.

Study Design:

Controlled laboratory study.

Methods:

Among 18 professional baseball pitchers, 38 reflective markers were positioned on the body and each player threw 32 to 40 maximum effort pitches—consisting of the fastball, curveball, slider, and changeup pitch types—from a regulation mound to a catcher. The markers were tracked by 18 high-speed 180-Hz cameras, and data were processed and run through a computer program to calculate 25 kinematic parameters, 7 kinetic parameters, and 4 temporal parameters for each pitch type and for both strikes and balls. A 2-way repeated-measures analysis of variance ($P < .01$) was used to assess pitching biomechanical differences among pitch type and pitch result (balls vs strikes).

Results:

During arm cocking, elbow varus torque was 8% to 9% greater in the fastball and slider compared with the changeup, shoulder horizontal adduction torque was 17% to 20% greater in the slider and curveball compared with the changeup, and shoulder anterior force was 13% greater in the curveball compared with the changeup. During arm deceleration, elbow flexor torque was 9% to 14% greater in the fastball compared with the curveball and changeup, and elbow and shoulder proximal forces were 10% to 14% greater in the fastball, slider, and curveball compared with the changeup. At ball release, forward trunk tilt was 16% to 19% greater in the fastball and curveball compared with the changeup, contralateral trunk tilt was 26% to 41% greater in the curveball compared with the slider and changeup, knee flexion was 18% greater in the changeup compared with the fastball, and the knee extended 7° more from lead foot contact to ball release in the fastball compared with the changeup. During arm cocking, pelvis angular velocity was 7% to 8% greater in the fastball compared with the curveball and changeup, and upper trunk angular velocity was 5% greater in the fastball compared with the changeup. During arm acceleration, shoulder internal rotation angular velocity was 6% to 7% greater in the fastball, slider, and curveball compared with the changeup, and ball velocity at ball release was 11% to 18% greater in the fastball compared with the slider, changeup, and curveball and 6% greater in the slider compared with the curveball. For all the kinematic, kinetic, and temporal parameters, analysis showed no significant differences between balls and strikes and no significant interactions between pitch type and pitch result.

Conclusion:

Nearly all kinetic differences among pitch types occurred between the changeup and the remaining 3 pitch types. Shoulder and elbow forces and torques and injury risk were greater among the fastball, slider, and curveball compared with the changeup but were similar among the fastball, slider, and curveball. Body segment and joint positions were similar among all pitch types at lead foot contact and at maximum shoulder external rotation; however, at ball release, throwing a fastball and curveball resulted in greater knee extension and more forward and contralateral trunk tilt compared with throwing a changeup and slider. Movement speeds for the pelvis, upper trunk, and shoulder were greatest in the fastball and least in the changeup and were generally similar among the fastball, slider, and curveball. The timing of when pelvis, upper trunk, elbow, and shoulder velocities occurred among the fastball, slider, curveball, and changeup was similar, and no kinematic or kinetic differences were noted between throwing balls and strikes.

Clinical Relevance:

The results from the current study will help clinicians understand differences in pitching biomechanics in professional baseball pitchers among the fastball, slider, curveball, and changeup; the study provides limited insight into shoulder and elbow injury risk associated with different types of pitches.

Keywords
pitching, pitch results, balls, strikes, professional baseball pitchers