

## BALLPARK FORCES: GROUND REACTION FORCES DURING BATTING

Dave Fortenbaugh and Glenn Fleisig

American Sports Medicine Institute, Birmingham, AL, USA

**KEY WORDS:** baseball, kinetics, timing

**INTRODUCTION:** The baseball swing is a three dimensional movement incorporating both propulsive and stabilizing forces applied by both feet throughout different phases of the movement. These ground reaction forces (GRFs) are subsequently transferred up through the body via the kinetic chain to generate bat velocity. Limited research exists on the magnitude and temporal sequencing of swing kinetics, and no known studies have analyzed the effect of ball location on swing kinetics.

**METHOD:** College baseball players (n=9) from a nationally-ranked university team took five swings from each of the nine subzones of the strike zone. One swing per subzone was used for analysis. All swings were performed indoors and off of a batting tee. The X axis was from home plate towards the pitcher, the Z axis was vertical, and the Y axis was the cross product of Z and X. Two Kistler force plates, sampling at 1250 Hz, recorded the triaxial GRFs of each foot. Force components (Fx, Fy, Fz) near three key events of the swing (initial rock back, forward drive, ball contact) were selected for analysis. The effect of ball location on swing kinetics was statistically analyzed using 3 x 3 ANOVAs with repeated measures for the magnitude and timing of forces in all three dimensions,  $\alpha = .05$ ,  $\beta = .20$ .

**RESULTS:** Figure 1 depicts a timeline of the average swing, with time in milliseconds prior to contact and GRFs in percent bodyweight (%BW). Among pitch locations, no differences were found in any temporal variables. Statistically significant differences were found among a few of the kinetic variables, though the differences were no more than 5% BW, or roughly 50 N.



**Figure 1: Timeline of the ground reaction forces of the baseball swing.**

**DISCUSSION:** Even though trends were seen in this and other previous studies to suggest a significant effect of pitch location on swing mechanics (Tago, 2006), a major limitation was that swings were done off of a tee. To accurately quantify the baseball swing, pitchers should throw to hitters to simulate a game atmosphere and fully incorporate the temporal aspects of the swing. A comprehensive approach which will measure both the kinematics and kinetics of "live batting" is the intended plan for future studies.

**CONCLUSION:** Differences do exist in swing kinetics among various pitch locations, though further research incorporating a more realistic simulation is required to achieve accurate results.

### REFERENCES:

Tago, Takahito et. al. (2006) Effects of inside and outside hitting point on joint angular kinematics in baseball batting. *Japanese Journal of Biomechanics in Sports & Exercise*, 10(4), 222-234.