IN-CLEAT LOADING PATTERNS DURING PITCHING IN COLLEGIATE BASEBALL PLAYERS

Michelle A. Aube, Scott D. Morin, Daniel T. Tarara, Kevin R. Ford

High Point University, High Point, NC, USA
email: aubem14@highpoint.edu web: highpoint.edu/physicaltherapy

INTRODUCTION

Developing repeatable and safe maximum baseball pitch velocity involves a complex kinetic sequence that begins with ground reaction forces (GRF) and ends with the release of the ball. Conflicting results have been found relating pitch velocity to the magnitude of force exerted by the drive leg and stride leg [1,2]. McNally et al. [2] recently identified the stride leg ground reaction forces were significantly related to ball velocity. In contrast, drive leg forces were not significantly correlated to ball velocity. Location of plantar loading has not been studied in great detail and may offer further insight into the generation of ball velocity. The purpose of this study was to determine if regional plantar loading was different between high velocity pitchers and low velocity pitchers during pitching off a mound.

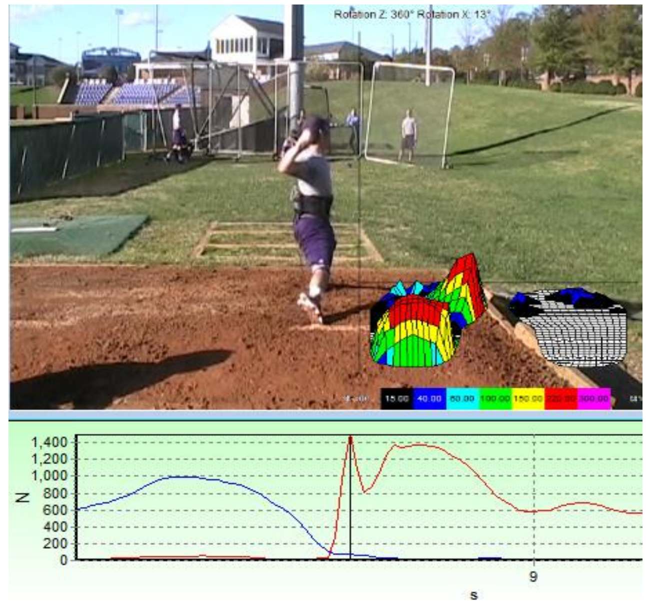

Figure 1: Video synchronized with in-cleat load distribution during fastball, high velocity pitcher

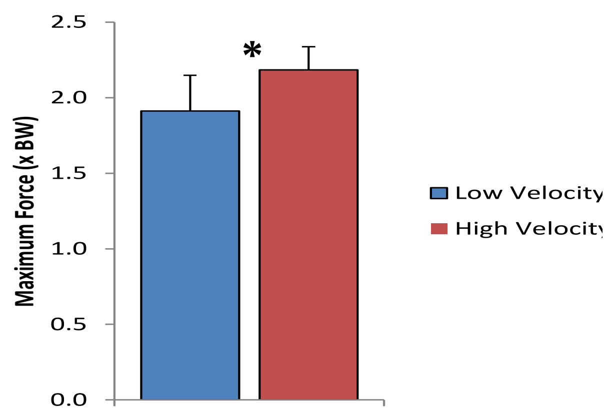

Figure 2: Total front stride foot maximum force during pitching (*p<0.05).

METHODS

Division I male baseball pitchers (n=15, mass 91.2±12.6kg, age 19.9±1.4yrs) volunteered to participate in the study. Pressure distribution insoles (pedar-x, novel) were placed in baseball specific cleats (poweralley 3, adidas). The insoles were attached to a data transmitter unit and secured around the participant's torso with a velcro belt. Insole data were collected at 100 Hz and calibrated to a known load of 900 kPa. Multiple digital video views were collected and synchronized to the pedar-x system. Each participant threw a series of warm-up pitches from a dirt, bullpen mound to become accustomed to the instrumentation. After completing the warm-up, each participant threw a series of 15 pitches at maximum effort. The first 5 fastballs were analyzed for this study. All pitches were performed from the wind-up, without a batter, to a catcher in full gear. The velocity of the ball was collected using a radar gun (Stalker Solo 2, Stalker Radar, Plano TX) positioned directly behind the catcher. Plantar foot loading of the drive leg was calculated between maximum knee height (visibly identified on video) to toe off (total insole force below 50N). Plantar foot loading of the stride leg was calculated from initial ground contact (total insole force exceeding 50N) to ball release (visibly identified on video). The maximum force was calculated for the total foot and nine defined regions: medial heel, lateral heel, medial midfoot, lateral midfoot, medial forefoot, central forefoot, lateral forefoot, hallux, and lesser toes. Force time integral was also calculated for the total foot and each region in order to calculate a relative load within each region. Two groups were determined based on average fastball velocity that were above less than 38 $m \cdot s^{-1}$ (85 mph, low velocity group (LV), n=10) and equal to or greater than 38 $m \cdot s^{-1}$ (85 mph, high velocity group (HV), n=5). One-way ANOVAs were used to test for significant differences between velocity groups ($p<0.05$).

RESULTS AND DISCUSSION

Average fastball velocity was 39.2±0.8 $m \cdot s^{-1}$ (87.6 mph) in HV compared to 35.9±1.9 $m \cdot s^{-1}$ (80.3 mph) in the LV group ($p=0.003$). Total stride leg maximum force was significantly greater in the high velocity pitchers compared to low velocity pitchers (Figure 2, LV 1.9±0.2 BW, HV 2.2±0.2 BW $p=0.037$). However, drive leg maximum force was not different between groups (LV 1.4±0.2 BW, HV 1.6±0.2 BW, $p=0.24$). Maximum force was not statistically different within the specific plantar regions for the stride leg or drive leg ($p>0.05$). Regional relative loading, however, was significantly different in two areas during the drive leg (Figure 3). HV pitchers had significantly increased relative loading in the lesser toes ($p=0.049$) and significantly less relative loading in the medial heel ($p=0.047$) compared to LV pitchers. Relative loading was not statistically different ($p>0.05$) in the stride leg.

CONCLUSIONS

GRF in pitching have been previously investigated using instrumented pitching mounds with multicomponent force plates to quantify drive and stride forces.[1,2] This study, to our knowledge, was the first to use pressure distribution insoles to measure regional foot loading in baseball specific cleats while pitching on an outdoor dirt mound. The higher stride foot landing maximal force observed in HV pitchers was consistent with previous findings which correlated landing forces with velocity [1,2]. Despite not demonstrating a difference in maximum force in the drive foot, variations in relative loading patterns showed lower loading of the medial heal and higher loading of the lesser toes in HV versus LV pitchers. Increased GRF in the drive foot have been reported in HV versus LV pitchers and along with greater momentum of the trunk and lower limb [3,4]. The altered drive foot loading may be a contributing factor in being able to generate greater pitch velocity leading to a coordinated sequencing of lower leg and trunk momentum. This finding supports the importance of leg drive in pitching and also may highlight the importance of foot mechanics as a coaching point to improved throwing mechanics or ball velocity. Caution should be used in interpreting these findings until further investigations quantify plantar loading variations in combination with lower limb, trunk, and upper arm kinematic and kinetics.

REFERENCES

1. MacWilliams et al. *AmJ Sports Med* **26**, 66-71. 1998.

2. McNally et al. *J Strength Cond Res* **29,** 2708-15. 2015.

3. Kageyama et al. *J Sports Sci Med* **13**, 742-750. 2014.

4. Kageyama et al. *J Sports Sci Med* **14**, 246-255. 2015.

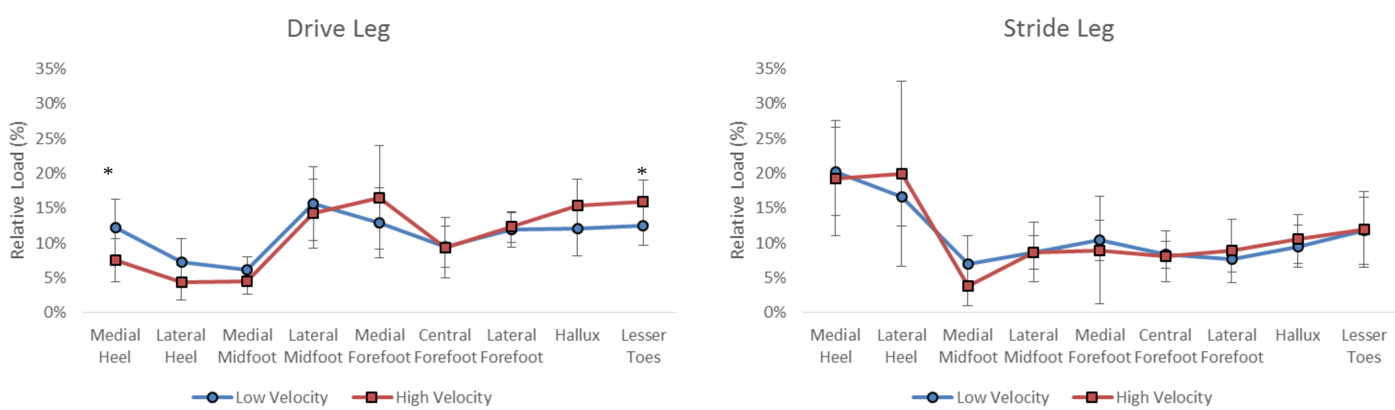

Figure 3: Relative loading of back drive leg and front stride foot during pitching (*$p<0.05$).