Impact of Finger–Ball Friction on Slip Distance on Baseball Pitching Performance

Takeshi Yamaguchi[1,2], Souta Suzuki[1], Shinnosuke Suzuki[1], Toshiaki Nishi[1], Takehiro Fukuda[3], Daiki Nasu[3]
[1]Graduate School of Engineering, Tohoku University, Sendai, Japan
[2] Graduate School of Biomedical Engineering, Tohoku University, Sendai, Japan
[3] NTT Communication Science Laboratories, NTT Corporation, Atsugi, Japan
Email: takeshi.yamaguchi.c8@tohoku.ac.jp

Summary

This study examined how finger–ball slip distance affects baseball pitching under different friction conditions. Six pitchers threw fastballs at 130 km/h under four conditions: no application, water-, rosin-, and pine resin-applications. High-speed camera analysis showed water-application caused the most slip (21.6 mm), over 140% more than rosin- and pine resin- applications. Increased slip reduced ball speed and spin while increasing pitch location variability.

Introduction

Friction between the fingers and the ball plays a crucial role in pitching performance, influencing ball spin and pitch control. However, no study has yet examined the relationship between fingertip–ball friction and baseball pitching performance. This study aimed to estimate the slip distance between the fingertips and the ball during the release phase of four-seam fastball pitching under varying friction conditions, using high-speed camera footage. Additionally, it explored how different friction conditions affect slip behavior and slip distance, as well as the relationship between slip distance and key pitching performance metrics.

Methods

Six experienced pitchers were instructed to throw four-seam fastballs at approximately 130 km/h toward a target behind home plate. The experiment varied finger–ball friction conditions, including no application, water application, rosin powder application, and pine resin application[1]. The slip distance (D_{slip}) during the ball release process—defined as the 8.0 ms interval from when the thumb left the ball to the moment of release—was estimated using high-speed camera footage (2000 fps) capturing the fingertips and ball. The relationship between the total slip distance (D_{total}) and key pitching performance metrics—including ball velocity, spin rate, vertical and horizontal arrival locations, and release angles measured using a Doppler radar tracking system —was analyzed.

Results and Discussion

As shown in Fig. 1A, D_{slip} tended to slightly increase and level off at t = −6.0 to −4.0 ms, except in the water application condition. Then, the normal force acting between the fingertip and ball decreased, which reduced the seam traction, resulting in an increase in D_{slip} at t = −4.0 to 0.0 ms. In contrast, in the water application condition, D_{slip} continued to increase until the moment of ball release (t = 0.0 ms). Total slip distance during the ball release process D_{total} was 142.3% and 163.8.% larger in the water application condition (21.6 ± 5.3 mm) than in the rosin powder (8.9 ± 3.5 mm, p = 0.022) and pine resin application conditions (8.2 ± 2.2 mm, p = 0.002), respectively (Fig. 1B). The ball spin rate had a moderate negative correlation with D_{total} (r_s = −0.523, p < 0.001). The ball velocity and vertical ball arrival location had weak negative (r_s = −0.314, p < 0.001) and positive correlations (r_s = 0.316, p < 0.001), respectively, with D_{total}. The vertical ball release angle had a moderate positive correlation with D_{total} (r_s = 0.478, p < 0.001).

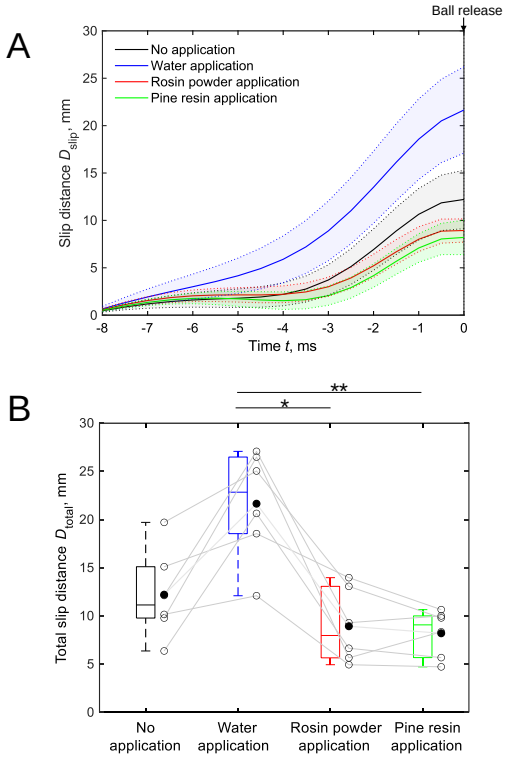

Figure 1: (A) Time series change in the group mean value of D_{slip} and (B) a boxplot of D_{total} for each finger–ball friction condition

Conclusions

This study is the first to examine the slip distance between the fingertips and the ball during baseball pitching. The results demonstrate that slip distance significantly influences pitching performance, affecting ball velocity, spin rate, and pitch control. These findings offer new insights into the mechanics of ball release under varying friction conditions and may contribute to enhancing pitching performance and reducing injury risk.

Reference

[1] Yamaguchi T et al. (2022). *Commun. Mater.*, **3**: 92.