

BASEBALL FEET-FIRST SLIDING TECHNIQUE

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The purpose of this current study was to investigate the difference of planned and unplanned baseball feet-first sliding techniques. Five male collegiate baseball players (NCAA II) were recruited. Each subject performed 3 successful trials of regular running, planned, and unplanned baseball feet-first sliding techniques to the third base. 3D motion analysis was used to obtain kinematic data during the last 25 feet (7.62 m) of the performance before contacting the third base. Results showed planned sliding technique had significant longest time when compared to unplanned and regular running to the base ($P < 0.01$). Running to base had significant greater average horizontal velocity than both sliding techniques ($P < 0.01$). Additionally, unplanned sliding technique had greater average horizontal velocity than planned sliding technique ($P < 0.01$).

KEY WORDS: baseball, kinematics, sliding technique.

INTRODUCTION: Baseball has been known as America's national pastime. Sliding is a technique used by runners to advance to the next base and to escape a defender trying to get an out on the opposite team. Sliding is categorized by two different types of techniques: head-first and feet-first. To the authors' best knowledge, there are only four studies which examined and compared the efficiency of both sliding techniques (Chang, Chang, Jong, & Chen, 2004; Corzatt, Groppe, Pfautsch, & Boscardin, 1984; Hosey, Mattacola, & Shapiro, 2003; Kane, House, & Overgaard, 2002). From the limited literature, studies showed that there was no statistical difference of overall time from first base to second base between two sliding techniques (Corzatt et al., 1984; Hosey et al., 2003; Kane et al., 2002). However, Chang et al. (2004) indicated it was significantly faster when athletes utilized the feet-first than head-first sliding technique while Kane et al. (2002) showed that the feet-first slide was slightly faster on average than head-first slide in all age/skill level of baseball players. Although the study from Kane et al. (2002) did not find significant differences between the two techniques, this small difference of time may be just enough of an advantage to result in the successful advance to the next base.

The decision of performing a sliding technique or not on the way toward second base usually depends on the runner. This is because the runner is traveling in the direction where he is facing the field and can see whether the defensive team can pass the ball to the second base on time or not (planned sliding). However, when a runner is traveling toward the third base, he will rely on the base coach to signal him if sliding is needed or not. In general, the runner would plan to get on third base without sliding unless the base coach instructed (unplanned sliding). The choice of using either feet- or head-first technique also depends on the runner's preference. Hosey et al. (2003) indicated that 90% of subjects perceived feet-first slide to be safer than head-first slide. Additionally, studies showed head-first sliding techniques have a higher risk of injury than feet-first technique (Dicks et al., 2007; Hosey & Puffer, 2000).

Although it is inconclusive as to which sliding technique is faster, the fundamental question is to determine whether advancing to the next base is faster with or without sliding performance. Moreover, the effect of third base coach's instruction on sliding performance has yet to be investigated. Therefore, the purpose of this study was to determine the kinematic difference between with and without feet-first sliding performance on base running and the effects of the instructions of a base coach on the feet-first sliding technique of a runner. We hypothesized that running toward third base would be faster than sliding toward

third base with or without base coach's instruction. The time to get on the third base would be shorter for unplanned sliding technique than planned sliding technique.

METHODS: All study methods were approved by the university Institutional Review Board for the use of human subjects. Five skilled male collegiate baseball players (NCAA II) volunteered for the study (BH: 1.78 ± 0.09 m; BW: 87.03 ± 14.89 kg). Each subject was required to warm up with their preferred routine and several trials of planned feet-first sliding technique in front of the cameras. All subjects performed three successful trials of regular sprint, planned, and unplanned feet-first sliding techniques according to the base coach's instruction. Planned trials included the subject knowing that they would slide into the next base before the trial began. Unplanned trials included a base coach instructing the subject to either slide or not to slide while the subject is running toward the base. For the unplanned slide, the base coach started with arms raised and if they wanted the subject to slide they would put their arms down, signaling to the subject that they need to transition into a feet-first slide. If the base coach did not put their arms down then the subject would continue to run to the base. To categorize the slide as unplanned, the subject ran several trials in which the base coach randomized directions for the subject to slide or not. Since each subject had a different lead start at second base, the performance during the last 25 feet (7.62 m) before the third base was recorded for further analysis. The feet-first sliding technique performance consisted of the last one to two steps of running before getting into sliding position and sliding performance.

Times for three conditions were compared from any marker on the body passed the 7.62 m to contacting the third base. In the feet-first sliding technique, times for each phase of performance in both planned and unplanned sliding were also obtained for further analysis: sprint, attainment of sliding position, airborne, and sliding phases (see Figure 1; Corzatt et al., 1984). Attainment of sliding position was defined the period of time to get body position ready for sliding performance. Peak and average horizontal velocities at CoM were also compared between three types of performance.

Three digital cameras (Cannon, 60 Hz) were used to obtain three-dimensional kinematic data. The videos were in conjunction with a motion analysis system (Vicon Motus: 9.2) and synchronized with Remote Audio Synchronization Unit. A model using 19 points which composed 14 segments was used. Anthropometric parameters from deLeva (1996) were used. All video trials were cropped from the 5th field before any body part of the subject passed the 7.62 m marker (25 feet) to the 5th field after any part of the subject contacted with the base. Since there was a period of sliding phase, manual digitization was performed and landmarks were then visually verified and filtering parameters were adjusted as needed. The coordinate data were filtered using quantile spline processing (Woltring, 1986; Winter, 1990). SPSS 22 was used to perform statistical analysis. Total time, peak, and average horizontal velocities at CoM were compared with one-way ANOVA and Tukey post hoc was further applied to determine the difference between groups. Independent t-test were performed to determine time difference in each phase between planned and unplanned sliding techniques. Effect size was also reported. All statistical significance was set at 0.05.

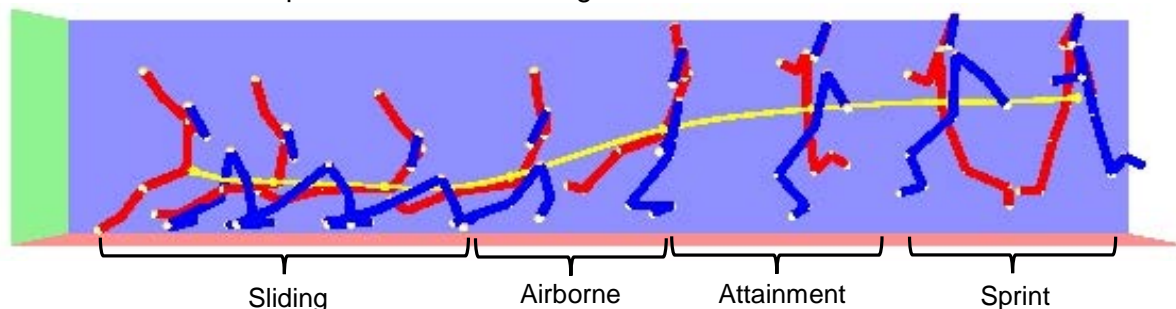


Figure 1. Phases of a planned feet-first sliding technique and variables that collected. Yellow line represents the CoM trajectory.

RESULTS: Table 1 shows all the means and SDs of each kinematic variable for the three different base running performances. There were significant differences of total time of base running between planned and unplanned sliding techniques and between planned sliding and regular running performances ($P < 0.01$). There were also significant differences of time spent in each phases between sliding techniques ($P < 0.01$). Although there was no significant difference of peak horizontal velocity at CoM, there were statistical difference of average horizontal velocity between the three types of performances ($P < 0.01$). Figure 2 represents one trial of planned and unplanned sliding techniques from a subject.

Table 1
Mean and SD of all the kinematic variables for base running performances

	Peak Vel. (m/s)	Average Vel. (m/s)	Total Time (s)	Sprint Time (s)	Attainment Time (s)	Air Time (s)	Sliding Time (s)
Planned	6.40 ± .63	5.11 ± .48*	1.23 ± .14*^	.38 ± .09*	.11 ± .03*	.16 ± .05*	.57 ± .18*
Unplanned	6.45 ± .36	5.61 ± .41*	1.09 ± .09*	.54 ± .11*	.24 ± .10*	.10 ± .02*	.22 ± .17*
Run	6.83 ± .43	6.14 ± .26*	1.07 ± .05^				
Effect Size				-0.62	-0.93	0.62	0.71

Note: Symbols represent significant difference between performances ($P < .01$).

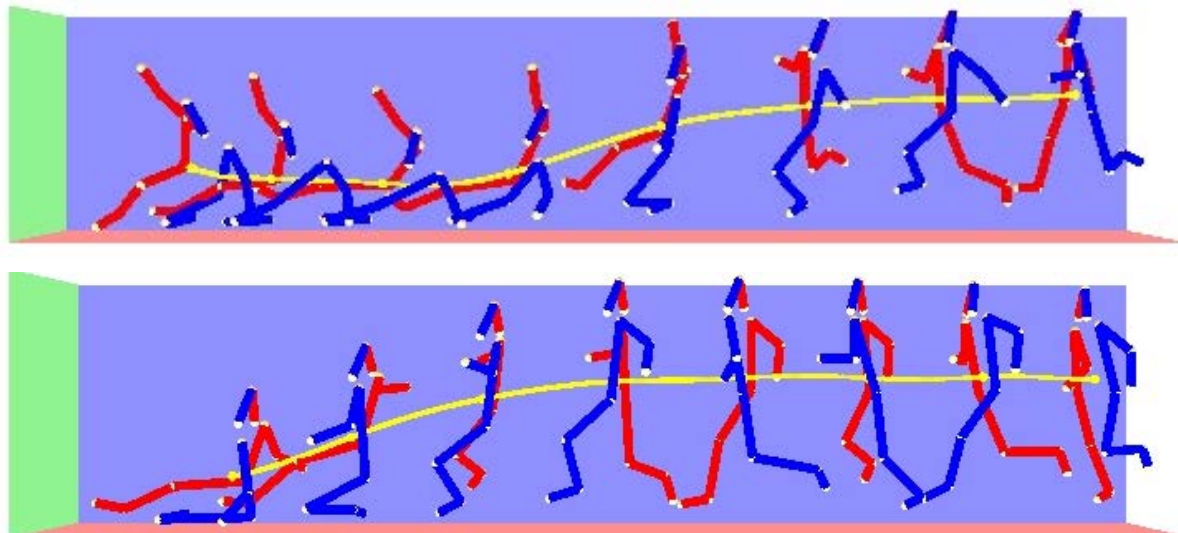


Figure 2. Figures on the top and bottom represent a trial of planned and unplanned of sliding techniques, respectively.

DISCUSSION: The findings of this current study was based on the last 25 feet (7.62 m) performance and assumed that the running performance were the same before that point from second base. It was found that it would be faster when a baseball players run regularly to the third base instead of using sliding technique. The regular running performance had a shorter time and higher average velocity than both planned and unplanned sliding techniques. Although there was no significant time difference between running performance and unplanned sliding technique, a fraction of a second can make difference of making it to the base successfully or not. Therefore, it can be concluded that sliding technique cannot be performed to advance to the next base faster. However, the sliding technique is performed to lower CoM and body parts to advance to the next base without being tagged out when a ball is passed back to the base high to the defender. In this way, the defender has farther distance to move the ball to tag the runner out. More studies are needed to determine the timing between the ball passing and sliding performance.

In comparing the two sliding techniques, unplanned sliding technique needed more time to get into the ready position before being airborne after the base coach gave the signal when compared to planned sliding technique. During this phase, players reacted to the signal by moving upper body first and then adjusted the foot work in order to takeoff with correct leg

which depended on player's preference. Although planned sliding technique had significant longer airborne phase than unplanned sliding technique, it could not overcome the longer sliding phase in planned sliding than unplanned sliding techniques. During this sliding phase, the body experienced friction which slowed down the movement. With longer sliding phase and friction, the product of these two factors is the cause of minimizing horizontal momentum of sliding techniques, especially for planned sliding technique (Kane et al., 2002).

Furthermore, planned sliding trails had a significant longer sliding time than unplanned trails. This is also due to the late signal given by the base coach, which caused the subject to start their slide at a closer distance to the base instead of a distance where they were comfortable with sliding into the base. In related to the time of slide, the average horizontal velocity of the unplanned technique (5.61 m/s) was significantly greater ($P < 0.01$) than the planned technique (5.11 m/s). This implies that the subject covered a smaller distance at a higher velocity which could be an indication of injury risk. Dick et al. (2007) concluded that a late decision to slide causes a greater force for a shorter amount of time, and hesitation to slide or late decision to slide increases the rate of injury for feet-first sliding. The limitations of the current study include but not limited to: 1) small sample size (a total of 45 trials), 2) only the last 25 feet of performance were analyzed, 3) the timing to give sliding signal by the base coach were not standardized, and 4) the clothing of the players during data collection were not the same which may result in different amount of friction.

CONCLUSION: Regular running to the base is the faster way to advance to next base with shorter time and greater average horizontal velocity not the sliding techniques. However, the sliding technique provides a better body posture with lower CoM and body parts when a ball is passed back high to the defender at the base. The planned sliding technique had a significantly longer time of the sliding phase when comparing to unplanned sliding technique which minimized the horizontal momentum of the players. Additionally, unplanned sliding technique needs more time to get into proper body posture before airborne with shorter sliding time and higher average velocity. This implies that unplanned sliding technique may have higher risk of injury than planned sliding technique.

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