A NEW APPROACH TO BASEBALL BAT SWING WARM-UP

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The purpose of this study was to compare a new form of warm-up with the traditional warm-up routine in baseball bat swing. Three different warm-up conditions (i.e., the standard bat warm-up (CO), the overweighted arm warm-up (OA), and the overweighted bat warm-up (OB)) were tested. Twenty subjects who had competitive baseball experience in high school or college participated in this study. Results indicated that during warm-up swings the bat speed of the CO (31.95 ± 1.50 m/s) was significantly faster than that of the OA (31.35 ± 1.82 m/s) and the OB (25.55 ± 1.43 m/s) ($p < .05$). However, the OA warm-up increased bat speed (0.659 ± 2.79%) more than the CO (0.049 ± 2.54%) and OB (–0.203 ± 3.83%) warm-ups. However, these differences were not statistically significant due to large variation across subjects. This study also found a significant drop of the bat speed at the first trial (–0.499 ± 3.21% and –1.07 ± 3.21% for the OA and OB warm-ups, respectively) immediately following loaded warm-ups. It was concluded that the overweighted arm warm-up might be better than the traditional warm-up routine (i.e., the overweighted bat) but a short break (e.g., 3-min) is recommended to maximize the performance.

KEY WORDS: baseball, bat swing, extra mass, open kinetic chain motion

INTRODUCTION:

In the game of baseball, most of the players use an overweighted bat for their warm-up swings in the on-deck circle. Previously anecdotally they believe the heavy bat will help to improve their bat speeds (according to personal communication with athletes). DeRenne and his colleague (DeRenne & Branco, 1986; DeRenne, Ho, Hetzler, & Chai, 1992) showed the bat speed improvement through a warm-up or training with ±10% change of the game bat weight. However, recent studies on the overweighted bat warm-up showed opposite result or no change on the bat speed following a warm-up (Kim & Hinrichs, 2005; Otsuji, Abe, & Kinoshita, 2002; Southard & Groomer, 2003). Then if the overweighted bat warm-up is detrimental to the bat speed, is there any good warm-up routine to improve bat speed?
This study was designed to answer these questions. Another study from our research group (see another abstract submitted to this conference) provided the possibility of improving the distal end speed with adding a mass for the proximal segment (i.e., the upper arm). However, it has not been applied to practical multi-joint sport skills.
Therefore, the purposes of this study were to apply a new form of warm-up (an overweighted arm warm-up) to baseball swings and to compare it with the traditional warm-up (i.e., the overweighted bat warm-up). It was hypothesized that the overweighted arm warm-up would produce not only a faster bat speed during the warm-up itself, but also improve bat speed following warm-up (after the weights are removed).

METHOD:

Data Collection: Twenty subjects participated in this study. All has competitive baseball experience in high school or college.
Three different warm-up conditions were designed (see Table 1).

Table 1 Descriptions of Warm-up Conditions

Name	Description	Mass
CO	Standard Bat (Control)	885 g bat only
OA	Overweighted Arm	885 g + 721 g on each upper arm = 2,327 g
OB	Overweighted Bat	885 g + 567 g donut = 1,452 g

The extra arm mass, 721 g (i.e., 35% of the upper arm mass), was determined by the results of the fundamental arm swing study (see another abstract submitted to this conference). It was placed on the center of mass of the upper arm. The 567 g donut was a commonly used extra weight by players.

Subjects performed a total of 35 swings, consisting of seven sets in the laboratory. All swing trials were performed as fast as possible. Each set included five swings. The first set was five trials of the standard bat swing with ball contact. It was defined as the pre-warm-up set of swings and was compared with other post-warm-up sets. After a 5-min rest, a warm-up set was applied. The order of warm-up conditions was decided by a counter-balanced design between the CO, OA, and OB conditions in advance. After the first warm-up set, there was a 2-min break before post-warm-up swings. In addition, a 5-min break was given before the next warm-up. The interval between trials was 20 s. A ball contact was required in pre- and post-warm-up swings while no ball contact was applied to warm-up swings.

The Advanced Motion Measurement-3D system (AMM-3D, Phoenix, AZ) was used to collect position data of the full body dynamic motion and to calculate angular and linear velocities (see Figure 1). It consisted of twelve electromagnetic sensors and the sampling rate was 240 Hz.

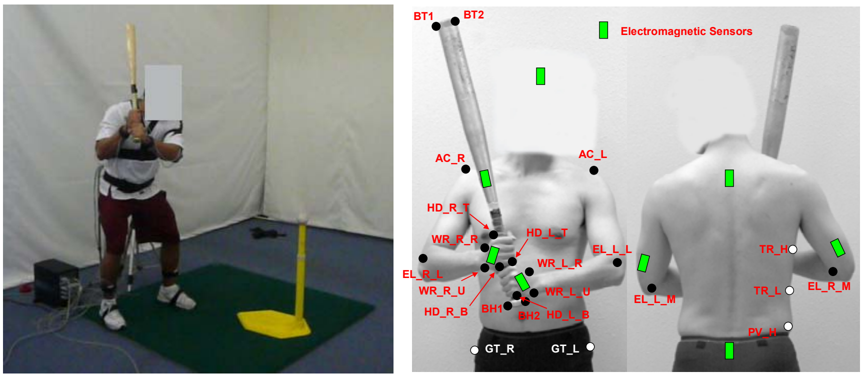

Figure 1: Experimental set-up: (A) the wired AMM-3D and the batting tee and (B) the locations of electromagnetic sensors and calibration points in the upper body.

Data Analysis: The bat speed (i.e., the peak bat tip linear velocity) and the change in bat speed were used for a one-way repeated measures ANOVA ($p < .05$).

RESULTS:

The expectation of faster bat speed of the OA swing was not supported. A one-way repeated measures ANOVA found a significant main effect of a warm-up but the bat speed of the standard bat (CO) (31.95 ± 1.50 m/s) was significantly faster than that of the OA (31.35 ± 1.82 m/s). The OB showed significantly lower bat speed (25.55 ± 1.43 m/s) even though the absolute extra mass of the OB (567 g) was smaller than that of the OA (1,442 g) (see Figure 2). This was because of the increased moment of inertia as a result of farther location of the mass.

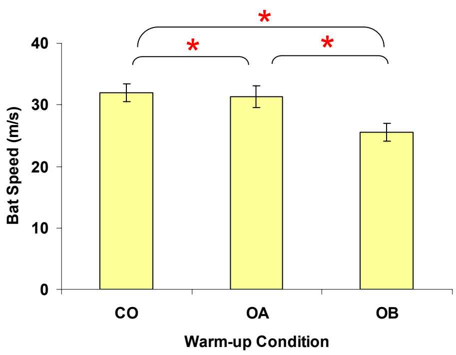

Figure 2: Bat speed according to different warm-ups. *Significant group difference was detected between levels ($p < .0167$).

The change in bat speed following different warm-ups was not statistically different between groups due to a large variation of bat speed across subjects ($p > .05$). Only the mean due to the OA (0.659 ± 2.79%) was higher than that of the CO (0.049 ± 2.54%) and the OB (–0.203 ± 3.83%) ($p > 0.05$) (see Figure 3). The OB warm-up slightly reduced the bat speed.

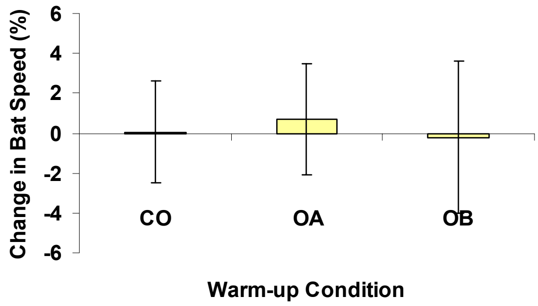

Figure 3: Change in bat speed after a warm-up: CO = the standard bat warm-up, OA = the overweighted arm warm-up, and OB = the overweighted bat warm-up.

Interestingly, the bat speed of the first trial immediately after the loaded warm-ups was significantly lower than subsequent trials in a simple contrast testing ($p < .05$) (see Figure 4). The first trial after the OA (–0.499 ± 3.21%) was lower than that of the third trial (0.83 ± 3.27%) and the fifth trial (1.28 ± 3.27%), respectively. The first trial after the OB (–1.07 ± 3.21%) was also lower than that of the fourth trial (0.173 ± 3.95%).

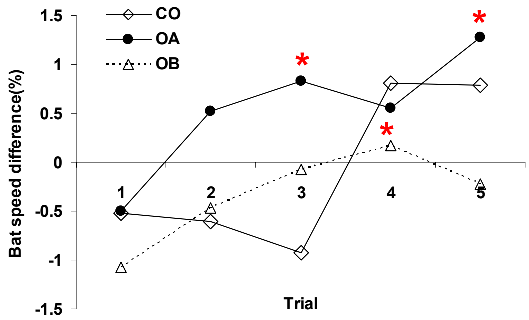

Figure 4: Bat speed differences according to trials during post-warm-up swings. *Significant mean difference was detected in comparison to the first trial in a simple contrast testing (p < .05)

DISCUSSION:

This study investigated the effect of the different warm-up conditions (i.e., the CO, OA, and OB warm-ups) on the bat speed and the change in bat speed. Our previous study using a planar arm swing task (Kim, 2008) found an increase in swing speed with an overweighted arm. However, in the present study, the extra mass added to the arms (35% extra mass) reduced the bat speed slightly. A couple of reasons might explain the discrepancy from the expectation. First, the extra mass for the upper arms might irritate the kinesthetic feeling and swing motion to a certain extent. This was because some subjects complained about the feeling of arm compression due to the extra mass after the experiment. Secondly, the amount of the extra mass (35% of upper arm) might not be best for bat speed improvement. There was a discrepancy between the arm swing system of the previous study (i.e., the three-segment model) and the current bat swing system (i.e., the four-segment model). The selection of the optimal extra mass should have been determined according to the four-segment model. Otherwise, the upper arm and the forearm together might be considered as one segment to apply the three-segment model in deciding the optimal extra mass.
However, the after-effect of a warm-up showed that the OA seemed better than the CO and the OB. The bat speed following the OA warm-up was slightly improved over pre-warm-up

while that following the OB warm-up was slightly reduced. Thus the overweighted bat (OB) warm-up seemed not beneficial to the bat swing speed similar to recent study findings (Kim & Hinrichs, 2005; Otsuji et al., 2002; Southard & Groomer, 2003). The overweighted bat should be avoided if players want to get an improved bat speed. However, if they use it for other purposes (e.g., stretching musculotendon unit), they should be careful because there is a negative effect immediately after the loaded warm-ups.

Otsuji et al. (2002) demonstrated the bat speed of the first trial immediately after the overweighted warm-up was significantly smaller (3% decrease in bat speed) than the pre-warm-up swings. This study did not support their finding but the first trial was statistically different from the subsequent trials after the loaded warm-ups (i.e., the OA and OB warm-ups). This might be an evidence of the interaction of fatigue and postactivation potentiation (PAP) after previous conditioning (Sale, 2002). Sale (2002) suggested the transient characteristics of fatigue and PAP in his review paper. Fatigue tends to attenuate relatively quickly but PAP does relatively slow so that the maximum effect of PAP would occur later than 3 min. He noticed most of the performance increase was found to be peak between 4 and 15 minutes after loaded exercises. Incidentally, the first trial of this study belonged to 2 min after a warm-up and the subsequent trials (3^{rd}, 4^{th}, and 5^{th} trials) occurred around 3-min or after 3-min. Thus, baseball players should think about a short-term performance drop immediately after the loaded warm-ups. It is recommended that they have a resting interval (around 3 min) with at least dry swings before real batting. This would be to maximize the effect of PAP and to wash out muscle memories or fatigues when they perform the loaded warm-ups in the on-deck circle.

CONCLUSION:

This study showed no benefit of the overweighted bat warm-up in the on-deck circle for improving bat speed. Rather players may want to try an overweighted arm warm-up instead even though it was not proven statistically. If baseball players have to use the overweighted bat for other purposes (e.g., stretching musculotendon unit), they should think about the speed drop immediately after the warm-up. Thus at least more than three dry swings with a 3-min break are recommended to maximize the effect of PAP and to minimize fatigue.

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