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Effects of a Weighted Pitching Sleeve on Range of Motion, Shoulder Strength, and Throwing Velocity in Collegiate-Aged Baseball Players

William Myers, Chelsea George, Heath McRae, & Adam McMahan
Department of Kinesiology

Abstract – Ample research has been done on the use of weighted implements, such as weighted balls, for increasing throwing performance in baseball pitchers. Research on weighted pitching sleeves, however, is far less available. The purpose of this study was to observe the effect of a weighted pitching sleeve on range of motion (ROM), strength, power, and throwing velocity in collegiate-aged baseball players. Six collegiate-aged baseball players were randomly assigned to one of two groups. The first group (n = 3; age 17.67 ± 1.03 yr; height 180.97 ± 5.01 cm; weight 84.03 ± 3.57 kg) consisted of subjects who wore a weighted pitching sleeve throughout a four-week throwing program. The second group (n = 3; age 19.00 ± 0.00 yr; height 177.25 ± 1.54 cm; weight 78.38 ± 5.71 kg) served as the control group and performed the same four-week throwing program without wearing a pitching sleeve. The throwing program consisted of 12 total sessions. Shoulder internal and external ROM, shoulder strength and power, and throwing velocity were tested both before and after the 4-week throwing program. A decrease in shoulder internal rotation ROM was found, while external rotation ROM increased for both groups. Both external rotation strength and power increased in the pitching sleeve group and decreased for the control group at each of the test speeds. No significant differences were observed between the groups for throwing velocity. These results indicate that the pitching sleeve had a positive effect on external rotation ROM, strength, and power.

I. Introduction

For baseball players, increasing throwing velocity, arm strength, and range of motion (ROM) is a common goal. Pitchers rely on strategy, ball movement, accuracy, and velocity to outsmart and outplay the batter. Greater velocity of the ball reduces the amount of time the batter has to visualize the ball’s movement and location, which makes it more difficult to achieve a hit, single, double, triple, or home run. Increased ROM can lead to decreased risk of injury and more optimal performance (Miyashita, et al., 2008). Figuring out the best methods of training to induce these improvements while decreasing the risk of injury is a mission that coaches spend a tremendous amount of time and resources trying to achieve. Current programming found in the literature (DeRenne, et al., 1990; Escamilla, et al., 2010; Syzmanski, et al., 2011) often focuses on high volume pitching programs as well as programs that include weighted implement training.

Using weighted balls to try and improve throwing velocity is something that has been studied and shown to have varying results throughout the literature. In a study by DeRenne, Ho, and Blitzblau (1990), the effects of both training with an over-weighted ball, as well as training with an under-weighted ball were observed and analyzed. The results of this study showed that the control group, the group that used under-weighted balls, and the group that used over-weighted balls all saw an increase in throwing velocity. The under-weighted and over-weighted ball groups, however, had a significantly greater improvement in throwing velocity than the control group. These results indicate that both training with an over-weighted and an under-weighted ball has a positive effect on throwing velocity. However, neither type of training delivered significantly better results than the other (DeRenne, et al., 1990). In another study looking at the effects of weighted implement training on throwing velocity, Symanski, et al. (2011), put participants through an eight-week training program in which half of the subjects trained with over-weighted ball, and the remaining subjects in the control group trained with a standard five oz. ball. Both groups also engaged in a resistance training program as a part of their training protocol. Results from this study showed no significant difference between using a weighted
ball during training and an increase in throwing velocity (Symanski, et al., 2011).

While findings related to weighted balls are inconsistent, preliminary research on weighted pitching sleeves indicates they may provide more reliable results and be a useful training modality for baseball players (Phantom Weights: Phantom Studies). The sleeve of choice for this study was the Phantom Throwing Sleeve (U.S. Patent No. 287,681, 2015). The Phantom Throwing Sleeve (Figure 1) and its effects on throwing velocity has been examined in other studies. In a study with the Rice University baseball club, all players exhibited an increase in velocity after a six-week training program, with an average increase of 3.8 miles per hour (Phantom Weights: Phantom Studies). In a similar study conducted with subjects from the Texas A&M University baseball club, subjects saw an average increase of six miles per hour at the end of an eight-week training program (Phantom Weights: Phantom Studies). In our study, only a throwing program was used rather than also incorporating a resistance training program as in the Symanski, et al. (2011) study. With this study, our goal was to add to the existing research pertaining to the effects of the Phantom Throwing Sleeve on performance in baseball players. By doing so, strength and conditioning professionals can better plan effective training programs for these athletes.

The purpose of this study was to look at the effect of a weighted pitching sleeve on ROM, strength, power, and throwing velocity, in collegiate-aged baseball players. Our hypothesis was that at the end of a four-week throwing program (Escamilla, et al., 2010), participants who wore the pitching sleeve during training (Figure 2) would see greater increases in ROM, shoulder strength and power, and throwing velocity.

**Figure 1:** Phantom Pitching Sleeve and weighted inserts

**Figure 2:** Phantom Pitching Sleeve being worn
II. Methods

Subjects
Six collegiate-aged (17-19) baseball players participated in the study. Subjects were excluded if they had a history of upper extremity injuries, such as rotator cuff, labral, or ulnar collateral ligament injuries. Players that throw from the side arm slot or submarine style were also excluded. Subjects were recruited via word of mouth and were informed of the study using a script. All subjects were required to sign an informed consent document as well as fill out an injury questionnaire to determine whether they were eligible to participate in the study (Yancy, 2018). The study was approved by the Institutional Review Board at the University of Alabama in Huntsville.

Instrumentation
Before performing a study for overhead athletes, it is necessary to measure the ROM on the dominant/throwing arm of each participant. The ROM data is essential in understanding what effect the throwing program and sleeve have on each participant pre and post data collection. A goniometer was used to measure the shoulder external and internal rotation ROM for the six athletes in the study (Sueyoshi, et al., 2017; Hurd, et al., 2011; Yu & Lee, 2012). All measurements were taken three times and the average was used for further statistics.

Strength and power of the shoulder muscles are important factors to measure when assessing overhead athletes. We measured strength and power of the internal, subscapularis, and external (infraspinatus and teres minor) shoulder rotators using an isokinetic dynamometer (Yin-Chou, et al., 2010; Baltaci & Tunay, 2004). If the participant has weak shoulder muscles, or performs poorly on dynamometer strength and power testing, a study involving numerous throws may lead to an increase in soreness of the shoulder girdle and possible overuse injury.

To precisely measure velocity of the ball, a Stalker Radar Gun (Applied Concepts Inc., Richardson, TX) was used with similar methodology to Huang, et al. (2011). A radar gun is more efficient than using a stopwatch to measure the time from the pitcher’s release of the ball to the initial contact with the catcher's mitt. For this study, the radar gun was manually operated by pointing the gun directly at the pitcher’s torso. Results were displayed with a digital reading in miles per hour.

Procedures
At the initial pre-testing session, subjects were presented with an informed consent document and asked to sign a waiver for participation. An injury survey (Yancy, 2018) was also presented to ensure that each subject was fit to participate in the study. Once these documents were completed, and it was determined that all subjects were eligible to participate in the study, the subjects were then tested for shoulder ROM and muscular strength and power in a laboratory setting.

Shoulder ROM measurements were taken from a supine position (Hurd & Kaufman, 2012). For external rotation (EROM) measurements, the shoulder was placed in 90 degrees of abduction, and the elbow in 90 degrees of flexion. The axis of the goniometer was aligned with the olecranon process of the elbow. The stationary arm of the goniometer was aligned with the midline of the forearm. The participant was instructed to externally rotate as far as they could, with no passive assistance used. Active internal range of motion (IROM) was also measured using the same goniometric landmarks. The shoulder remained in 90 degrees of abduction and the elbow in 90 degrees of flexion.

Once pre-throwing program ROM data was collected, shoulder strength and power were assessed using the isokinetic dynamometer. The participant was placed in a supine position with the shoulder at 90 degrees of abduction and the elbow at 90 degrees of flexion. Five submaximal repetitions were performed followed by five maximal repetitions at each of three testing speeds: 60, 120, and 180 degrees/second. One minute of rest was given between each set.

Following the collection of the laboratory measures, subjects were taken to a baseball field on the University of Alabama in Huntsville campus to test throwing velocity. Subjects first warmed up by throwing with a partner until they felt that they were ready to throw at their maximum velocity. Once the warm-up was complete, each subject threw from a pitching mound from a distance of 18.4 meters for 10 throws, (Huang, et al., 2011), and their velocity was measured using the Stalker radar gun. The gun was sighted at the torso of the thrower to reduce the number of flaws in information due to the many moving components of the throwing motion (Goble, Marino, & Potvin, 2003). As the ball was pitched, the radar gun
displayed a number in miles per hour (mph) that is directly correlated with the velocity of the ball with accuracy to within +/- 0.5 mph (Crotin, Bhan, Karakolis, & Ramsey, 2013). For this study, the subjects threw 10 maximal throws, and their highest throwing velocity was recorded and analyzed.

Subjects were then randomly assigned into the control group (n=3) or the weighted sleeve group (n=3). All six subjects completed a four-week throwing program in which they threw three times a week, for 12 total sessions, similar to the training protocol for a study performed by Escamilla, et al. (2010). The throwing sessions were conducted with a researcher observing and directing each stage for all sessions. Throwing sessions began by having subjects perform a proper warm-up using a tubed rubber band with wrist attachments that can be affixed to fences or poles using the metal clip attached (Jaeger Sports: Training Programs). Resistance bands are used to stretch and activate muscles used in throwing. Following the warm-up, the throwing program was performed. All subjects performed the same training regimen from warm-up to cool-down. Once the four-week training program was complete, ROM, muscular strength and power, and throwing velocity were again tested using the same instruments and procedures performed for pretest measurements.

Statistical Analysis

In order to compare pretest data with post-test data for the group wearing the weighted sleeve as well as the control group, a 2-way mixed design analysis of variance (ANOVA) was performed for the variables. The ANOVA shows whether there was a significant statistical difference in ROM, strength, power, and throwing velocity within the two groups pre and post, as well as across groups. An alpha level of $p \leq .05$ was set as the significance level. Effect size was evaluated with $\eta^2$ (Eta partial squared), where $\eta^2 < 0.06$ constitutes a small effect, $0.06 < \eta^2 < 0.14$ shows a medium effect, and $0.14 < \eta^2$ is a large effect (Cohen, 1988). All statistical analyses were performed using SPSS (v23, SPSS Inc., Chicago, IL).

III. Results

Pretest data showed a statistically significant difference in age ($p = .016$) between the pitching sleeve and control groups. There was no significant difference in height or weight between the groups (Table 1). Pre- and post-intervention data is presented as mean ± SD for ROM, strength, power, and velocity (Table 2). No significant differences were found for ROM ($F \geq .013$, $p \geq .895$, $\eta^2 \leq .002$). No significant differences were observed for strength at any of the tested speeds ($F \geq .092$, $p \geq .554$, $\eta^2 \geq .045$). For power, no significant differences were observed for any of the tested speeds ($F \geq .106$, $p \geq .701$, $\eta^2 \geq .013$). No significant changes were found for velocity ($F \geq .289$, $p \leq .605$, $\eta^2 \geq .035$).

Although no significant changes were found, there were some trends found within the data. For ROM, a loss of IROM and an increase in EROM were noticed in both the control and the pitching sleeve groups. For external rotation strength (ERS) and external rotation power (ERP), an increase was observed in the pitching sleeve group and a decrease in the control group. Minimal changes were observed for velocity between tests and across groups.
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Table 2: Changes in dependent variables between pitching sleeve and control group across the training period

<table>
<thead>
<tr>
<th></th>
<th>Pitching Sleeve Group (n=3)</th>
<th>Control Group (n=3)</th>
<th>Effect Size ($\eta^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ROM</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IR (°)</td>
<td>42.43 ± 11.61</td>
<td>42.13 ± 15.58</td>
<td>53.19 ± 8.88</td>
</tr>
<tr>
<td>ER (°)</td>
<td>65.22 ± 10.59</td>
<td>67.20 ± 15.79</td>
<td>73.22 ± 5.67</td>
</tr>
<tr>
<td><strong>Strength</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IR 60 (N/m)</td>
<td>36.00 ± 7.21</td>
<td>37.33 ± 5.69</td>
<td>39.00 ± 21.93</td>
</tr>
<tr>
<td>ER 60 (N/m)</td>
<td>30.33 ± 3.06</td>
<td>32.67 ± 4.51</td>
<td>35.67 ± 9.29</td>
</tr>
<tr>
<td>IR 120 (N/m)</td>
<td>26.33 ± 9.07</td>
<td>31.00 ± 3.00</td>
<td>30.67 ± 20.75</td>
</tr>
<tr>
<td>ER 120 (N/m)</td>
<td>22.00 ± 3.46</td>
<td>29.33 ± 2.89</td>
<td>28.33 ± 12.10</td>
</tr>
<tr>
<td>IR 180 (N/m)</td>
<td>20.00 ± 5.20</td>
<td>25.67 ± 3.79</td>
<td>26.00 ± 16.09</td>
</tr>
<tr>
<td>ER 180 (N/m)</td>
<td>17.00 ± 7.21</td>
<td>24.33 ± 4.62</td>
<td>23.00 ± 9.85</td>
</tr>
<tr>
<td><strong>Power</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IR 60 (W)</td>
<td>28.33 ± 6.43</td>
<td>30.67 ± 3.51</td>
<td>31.67 ± 18.50</td>
</tr>
<tr>
<td>ER 60 (W)</td>
<td>24.33 ± 2.31</td>
<td>28.33 ± 3.51</td>
<td>30.67 ± 7.37</td>
</tr>
<tr>
<td>IR 120 (W)</td>
<td>36.67 ± 14.47</td>
<td>47.00 ± 4.58</td>
<td>43.00 ± 36.29</td>
</tr>
<tr>
<td>ER 120 (W)</td>
<td>33.00 ± 7.81</td>
<td>47.00 ± 7.00</td>
<td>42.67 ± 22.37</td>
</tr>
<tr>
<td>IR 180 (W)</td>
<td>34.00 ± 19.05</td>
<td>48.33 ± 5.51</td>
<td>45.00 ± 43.28</td>
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<tr>
<td>ER 180 (W)</td>
<td>31.67 ± 19.09</td>
<td>50.33 ± 10.69</td>
<td>41.33 ± 28.73</td>
</tr>
<tr>
<td><strong>Velocity</strong></td>
<td>m/s</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>36.06 ± 2.46</td>
<td>35.47 ± 2.70</td>
<td>35.17 ± 1.44</td>
</tr>
</tbody>
</table>
IV. Discussion

In this study, the effect of a weighted pitching sleeve on ROM, strength, power, and throwing velocity, in collegiate-aged baseball players was investigated. Although no significant changes were found, there were some similarities and differences in the data gathered. At baseline, the control group had considerably more ROM than the pitching sleeve group for IROM and EROM. An increase in EROM was seen from pre to post testing in both groups. However, at the end of the program, IROM decreased in both groups, showing similar changes in both groups. This shows that in a short throwing program ROM may not be affected drastically by a weighted pitching sleeve. In a previous study which utilized weighted balls (Donatelli, et al., 2000), results indicated an increase in EROM in subjects who used the weighted ball, as well as a decrease in IROM. The results of this study were consistent with those found in our study. Decreased IROM may be due to increased anterior humeral head translation and superior migration, but the exact cause needs to be further investigated (Donatelli, et al., 2000).

This study did not show any significant changes in ERS and IRS ($\eta^2 \geq .124$). However, non-significant increases in ERS were observed in the pitching sleeve group opposed to a decrease in the control group. At 60 deg/sec the pitching sleeve group saw a 7.71% increase in strength whereas the control group had a decrease of 14.97%. This trend is noticed to gradually increase as dynamometer speed increased, indicating more of an effect at more sport-specific test speeds. At 120 deg/sec, the pitching sleeve group again saw an increase in strength of 33.32%, and the control group saw a decrease of 4.70%. At 180 deg/sec, the pitching sleeve group had a further increase in strength of 43.12%, and the control group saw a decrease of 11.6%. Although none of these changes were statistically significantly different between the two groups, a medium effect size was found for ERS ($\eta^2 \leq .202$), which indicates that the pitching sleeve did have a positive effect on ERS.

While none of the power values at any of the tested speeds were significantly different between the pitching sleeve and the control group ($p \geq .192$), the data suggested an increase in ERP in the pitching sleeve group and a decrease in the control group as a result of the study. While there was no significant difference between the two groups at 60 deg/sec, a large effect size ($\eta^2 = .202$) was seen. The pitching sleeve group saw a 16.44% increase in power while the control group had a 15.23% decrease. A medium effect size ($\eta^2 = .124$) was seen in ERP at 120 deg/sec as the pitching sleeve group again experienced an increase in power of 6.68% while the control group decreased by 6.3%. These numbers indicate that while there was not a significant difference between the two groups, wearing the pitching sleeve did have a positive effect on ERP. An increase in ERP is consistent with the findings of a study by Wooden, et al. (1992) in which an increase in ERP was seen in baseball players participating in both isokinetic and variable resistance mode strength training programs. In our study, which would be comparable to the variable resistance mode of strength training in the study by Wooden, et al., no significant improvement in internal rotation power (IRP) was observed from incorporating weighted training.

Velocity pre and post testing measures show a decrease of 1.64% in throwing velocity over the course of the four-week throwing program for the pitching sleeve group. These results are consistent with the findings of Symanski, et al. (2011). In this study, both groups engaged in resistance training using resistance bands, which is similar to the protocol of that study. Neither study saw an increase in throwing velocity when using some form of weighted implement to train. In our study, the control group showed a slight increase in velocity (2.1%). These changes in velocity were not found to be statistically significant ($p = .605$). One subject in the control group saw an increase of three mph, creating an outlier in the data. With more subjects, this outlier would not have had affected the data as much as it did.

Some of the feedback gained through the throwing program from individuals using the pitching sleeve was that the throws performed had a better finish than before. This could be due to the weights in the sleeve making the arm follow through more consistently along with keeping the index and middle fingers pushing the ball. Another common comment was how the release point, the point at which the ball leaves the fingers of the thrower, was not affected with the increase or decrease of weight. A negative observation for the pitching sleeve was how the sleeve fit the arms of some of the participants. Each participant’s sleeve fit well when stationary and dry, but due to sweat the sleeve became wet and did not
hold proper position during the challenging portions of
the throwing process.

A further limitation of this study was the sample size. Subject age was shown to be significantly different among the two groups. While the ages did not range much, one outlier has a large effect when dealing with a small sample size. Further studies containing more subjects should be performed in order to produce more definitive conclusions, and to have a more homogenous sample. We also believe that a longer training program would allow for better results. A final limitation to this study was that the only available training space was outdoors, which became an issue in the case of bad weather. We would have liked for the training days to be consistent from week to week, and this was not always the case depending on weather conditions. Future studies should utilize indoor training spaces in order to avoid this potential issue.

VI. Acknowledgements

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