

Skeletal Muscle Damage After Pitching Real Games in Collegiate Baseball Pitchers

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Abstract

Baseball pitchers are at risk for elbow and shoulder injuries. It is believed that many arm injuries in baseball pitchers result from cumulative microtrauma. The aim of this study was to investigate skeletal muscle damage after real games in Division I collegiate starting and relief pitchers. In order to examine the potential accumulation of muscle damage, the same procedure was performed in the beginning and end of a 3-month tournament. The first study included 4 starting pitchers and 5 relief pitchers. The second study included 3 starting pitchers and 5 relief pitchers. Plasma samples were collected the day before and 0 min, 30 min, 24 hr, 3 days, and 4 days after pitching a real game. For starting pitchers, plasma LDH was significantly increased immediately after pitching in the first study, and immediately and 30 min after in the second study. Plasma CK was significantly elevated immediately and 30 min after in the second study. For relief pitchers, LDH was significantly higher immediately after pitching in the second study. Plasma CK was unchanged in both studies. The pitching-induced muscle damage was similar between the 2 studies in both starting and relief pitchers. The results of this study indicated that starting pitchers may suffer the skeletal muscle damage after pitching a real game. However, the muscle damage appeared to be fully recovered within 24 hr. On the other hand, there was no significant muscle damage after pitching a real game in relief pitchers. In addition, a 3-month season did not result in accumulation of muscle damage in collegiate pitchers.

Keywords: Eccentric exercise, Creatine kinase, Lactate dehydrogenase

Introduction

Baseball pitchers are at risk for elbow and shoulder injuries. The incidence rates of elbow or shoulder pain in American youth and high school pitchers have been estimated as 26-58% [1, 2]. The risk factors for elbow and shoulder pain in youth pitchers may include the numbers of games and pitches, arm fatigue during the game pitched, and pitched with higher velocity [1, 3]. It has also been suggested that throwing curveball increased the risk of shoulder pain by 52%, while throwing sliders increased the risk of elbow pain by 86% in 9-14-year-old players, compared to throwing fastballs. On the other hand, throwing change-up did not change the risk for shoulder or elbow pain [4]. However, a biomechanical study revealed that throwing curveballs produced similar mechanical loading in arms, compared to fastballs in youth and collegiate pitchers [5].

It is believed that many arm injuries in baseball pitchers

result from cumulative microtrauma that began at the youth level [6]. The deceleration phase is the most violent of the throwing cycle, with powerful eccentric contraction of all muscle groups to decelerate the arm [7]. It has been well-documented that repeated eccentric contractions result in significant muscle damage, indicated by the elevation in plasma levels of creatine kinase (CK) and lactate dehydrogenase (LDH) [8-10]. Therefore, it is crucial to determine the sufficient time for recovery between throwing in practices and games to prevent the accumulation and worsening of muscle damage in baseball pitchers. The aim of this study was to investigate skeletal muscle damage after real games in collegiate starting and relief pitchers. In order to examine the potential accumulation of muscle damage during a 3-month competitive season, the same procedure was performed in the beginning and end of the season.

Method

Subjects

The subjects were recruited from 2 Division I collegiate baseball teams. The first study included 4 starting pitchers (age 21.5±1.7 years, height 1.80±0.06 m, weight 81.3±7.6 kg,

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mean±SD) and 5 relief pitchers (age 21.2±1.3 years, height 1.81±0.02 m, weight 79.2±5.7 kg). The second study included 3 starting pitchers (age 21.0±1.7 years, height 1.80±0.07 m, weight 80.1±9.2 kg, mean±SD) and 5 relief pitchers (age 21.2±1.6 years, height 1.78±0.06 m, weight 75.0±8.3 kg). Each subject gave their written consent.

Study Period

The studies were undertaken during the 2007 spring tournament. The tournament was held between mid-March and mid-May, with a one-week playoff in late May. Each team usually played 3 games per week, with most games played on Mondays, Fridays and weekends. The first study was undertaken in late March, while the second study was undertaken in early May.

Blood collection and analysis

In both studies, the overnight fasting blood sample collected the day before pitching served as the baseline. Venous blood samples were collected immediately, 30 min, 60 min, and 24 hr after the game. On the morning of the third and fourth day after pitching, overnight fasting venous blood samples were also collected. Plasma was obtained by centrifuge at 1500 x g for 20 min at 4°C. Plasma levels of LDH, CK, and lactate were analyzed using commercial kits on an automatic analyzer (Hitachi 7020, Ibaraki, Japan).

Statistical analysis

All values were expressed as means±SEM. The difference between baseline and other time points in LDH, CK, and lactate were analyzed by Student's paired t-test. The analysis was performed with SPSS for Windows 10.0 (SPSS Inc., Chicago, IL, USA). A p-value less than 0.05 was considered statistically significant.

Results

Plasma LDH in starting pitchers after a real game in the first and second study are shown in Figure 1. In the first study, LDH was significantly increased immediately after the game (438.3±52.5, range 359-560 U/L), then returned to the baseline (350.0±41.1, range 290-471 U/L). In the second study, LDH was significantly increased immediately (455.3±31.3, range 407-514 U/L) and 30 min (433.0±34.6, range 394-502 U/L) after the game, compared to the baseline (339.0±28.1, range 308-395 U/L). Plasma CK in starting pitchers in the 2 studies are shown in Figure 2. In the first study, CK concentrations were similar in all sampling points, although the average values showed a trend of increase immediately, 30 min, and 24 hr after the game. In the second study, plasma CK was significantly higher immediately (299.3±17.9, range 280-335 U/L) and 30 min after pitching (310.0±18.7, range 287-347 U/L) than the basal level (230.7±12.1, range 209-251 U/L). Plasma lactate concentrations were significantly elevated immediately after the game in starting pitchers in both 2 studies, then returned to the baseline 30 min later (Figure 3).

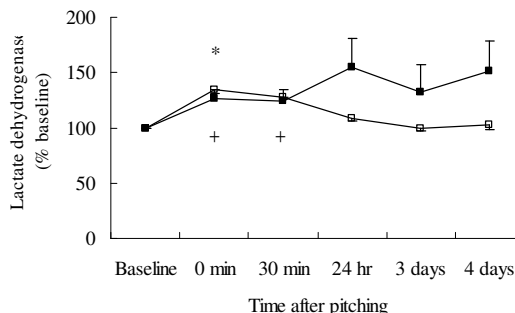


Figure 1. Plasma lactate dehydrogenase levels after pitching in the first (■) and second (□) study in starting pitchers. *p<0.05 compared to baseline in the first study; +p<0.05 compared to baseline in the second study.

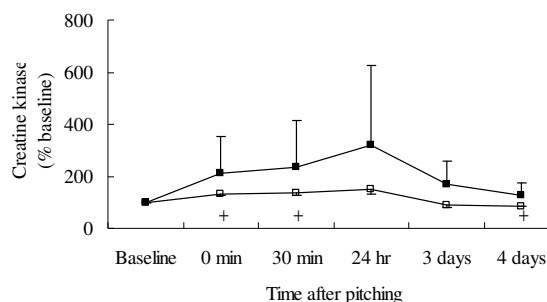


Figure 2. Plasma creatine kinase levels after pitching in the first (■) and second (□) study in starting pitchers. *p<0.05 compared to baseline in the first study; +p<0.05 compared to baseline in the second study.

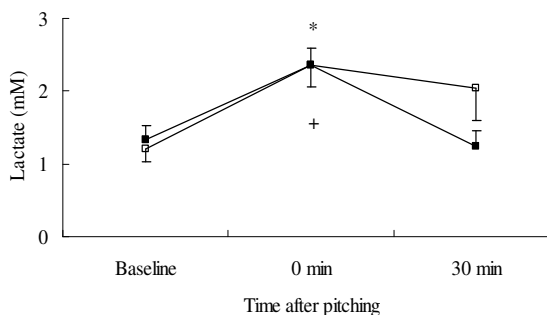


Figure 3. Plasma lactate concentrations after pitching in the first (■) and second (□) study in starting pitchers. *p<0.05 compared to baseline in the first study; +p<0.05 compared to baseline in the second study.

In the first study, plasma LDH levels in relief pitchers did not show significant change from the baseline (350.0±41.1, range 290-471 U/L) after a real game (Figure 4). In the second study, plasma LDH was significantly higher immediately after the game (451.0±29.9, range 387-510 U/L), compared to the baseline (352.5±26.1, range 288-416 U/L). Plasma CK levels were unchanged in relief pitchers after the games in both

studies (Figure 5), although it showed an increasing trend within 24 hr after the game in the first study. Plasma lactate concentrations remained unchanged after the game in relief pitchers in both studies (Figure 6).

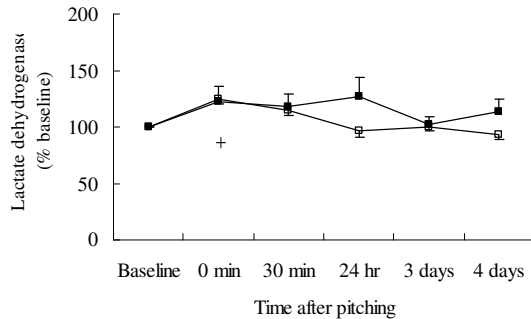


Figure 4. Plasma lactate dehydrogenase levels after pitching in the first (■) and second (□) study in relief pitchers. * $p < 0.05$ compared to baseline in the second study.

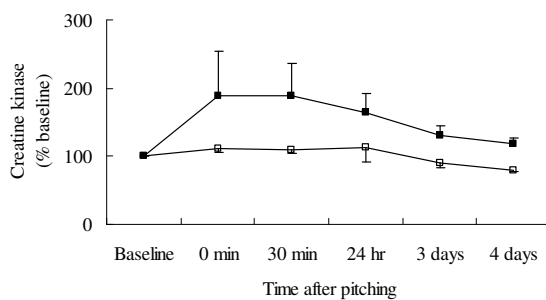


Figure 5. Plasma creatine kinase levels after pitching in the first (■) and second (□) study in relief pitchers.

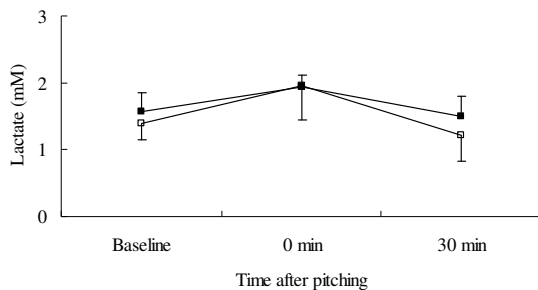


Figure 6. Plasma lactate concentrations after pitching in the first (■) and second (□) study in relief pitchers.

Discussion

To our knowledge, this is the first study to investigate the markers of muscle damage after a real competition in baseball pitchers of any level. The results of this study indicated that starting pitchers may suffer the skeletal muscle damage after

pitching a real game. However, the muscle damage appeared to be fully recovered within 24 hr. On the other hand, there was no significant muscle damage after pitching a real game in relief pitchers. In addition, a 3-month season did not result in accumulation of muscle damage in collegiate pitchers.

Only 1 previous study has examined the muscle damage markers after baseball pitching [11]. It showed that serum LDH was significantly elevated 6 hr after, while CK was significantly elevated 24 hr after a 98-pitch simulated game in subjects with prior pitching experience [11]. In addition, pitching after 2 and 4 days of rest resulted in similar post-exercise changes in the 2 enzymes. The magnitudes of increase in plasma LDH and CK levels after pitching in our study was larger than those in Potteiger et al [11], probably because our subjects were well-trained and played in more stressful real competitions.

The post-exercise changes in plasma LDH and CK levels varied significantly in the literature, probably due to the differences in exercise types and the training level of the subjects. It has been shown that plasma LDH and CK levels were elevated 24 hr after a half-marathon in trained athletes [12], while remained above the basal level for 1-2 weeks after a marathon in recreational runners [13]. In addition, the exercise-induced increase in LDH and CK levels may last for 72 hr after an intense bout of plyometric jumping exercises [14] and 96 hr after eccentric arm and leg exercises [8, 15]. The magnitude of exercise-induced increase in LDH ranged from approximately 30% [16] to 200% [8, 13]. Furthermore, CK levels could increase by 15 folds after a half-marathon [13] and 40 folds after eccentric exercise in elbow flexors [8]. The increases in LDH and CK after pitching in our subjects were smaller than those reported in eccentric arm and leg exercises [8, 15]. In addition, a large inter-subject variability in CK elevations induced by eccentric elbow flexor exercise has been reported [17]. Our subjects also showed a wide range of LDH and CK changes after pitching. Therefore, it is important to follow each pitcher individually to establish the personalized recovery schedule.

One of the limitations of this study is that the large variation in pitch counts of each subject. The pitch counts for the starting pitchers were 41-108 in the first study and 78-86 in the second study. The pitch counts for the relief pitchers were 7-26 and 5-44 in the first and second study, respectively. The variation in pitch count in this study is inevitable because the coaches made the decision to change pitchers according to the game situations. Nonetheless, this study still provided invaluable information on muscle damages induced by baseball pitching in real competitions. The physical loading in real game situations may not be completely duplicated in controlled laboratory settings.

It has been suggested that training could reduce the muscle damage in the subsequent exercise. elbow flexors can perform high-intensity eccentric exercise in the early stage of recovery from the initial bout and are not damaged further by performing a subsequent bout 3 days after the first [18]. The present study indicated that pitching-induced muscle damage was similar between the 2 studies in both starting and relief pitchers. The basal levels of LDH and CK were also similar in both studies.

Therefore, the 5-6 days of rest between starts for starting pitchers may be sufficient for muscle recovery. In addition, an outing with less than 30-40 pitches appeared to be tolerable in relievers without acute or accumulating effect on muscle damage. Future studies should focus on the markers for tendon and cartilage damages in baseball pitchers with different ages and training background.

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