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EFFECTS OF A FOUR-WEEK ELASTIC TUBING TRAINING ON THROWING PERFORMANCE IN YOUTH BASEBALL PLAYERS

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The purpose of this study was to identify the training effect of elastic tubing exercise in youth baseball players on throwing velocity, throwing accuracy and parameters of pitching mechanics. Participants (n=24) aging from 13 to 16 years old were equally and randomly allocated to the training group and control group. A four-week elastic tubing training was conducted in the training group. After four weeks of training, throwing velocity in training group improved significantly. Kinematics changed significantly mainly in parameters of shoulder and elbow. Since the muscular strength did not improve significantly, we may attribute the improvement to the effect of neural adaptation mechanism caused by training.

KEY WORDS: youth, pitching, elastic tube.

INTRODUCTION: Participants in baseball at the youth level constitute approximately 80% of all players. With such great number of youth baseball players, it is highly recommended that trainers and therapists should be knowledgeable in enhancing performance and preventing injuries in youth players. Since elastic tube is inexpensive, excellent in portability and the ease of use, it is one of the best choices for training baseball players. However, there are few studies investigating the training effect of elastic tubing programs on throwing performance, including throwing velocity and throwing accuracy, especially for youth players. Therefore, the purpose of this study is to determine the training effect of elastic tubing exercise in youth baseball players on throwing velocity, throwing accuracy and parameters of pitching mechanics.

METHODS: The procedure was subdivided into three parts: pre-test, training, lasting for four weeks, and post-test. Participants were equally and randomly assigned to the training group and control group. During pre-test, basic data including height, weight, range of motion, etc. were collected. Muscular strength was assessed in pre-test and post-test. Vicon system with six cameras was used to collect the kinematic data in pitching. A calibrated radar gun was used to record the throwing velocity while the force sensor was applied in detecting the location of throwing ball. Tests of FTPI were performed then. Players in training group followed a four-week elastic tubing training program with three times per week. The program consisted of elbow extension, elbow flexion, horizontal shoulder abduction, reverse chest fly, rowing, internal rotation with shoulder abducted 0^{o}, external rotation with shoulder abducted 0^{o}, standard throw, and reverse throw. To compare the baseline data between two groups, independent t test and Wilcoxon signed-ranks test were used for variables with normal distribution and non-normal distribution, respectively. A 2x2 ANOVA was used to examine the group and time effects on variables before and after training. The significance level was set to 0.05.

RESULTS: The basic data did not show significant differences between groups. After four weeks of training, muscular strength only showed significant difference in internal rotation while showing a trend of increase in other muscle groups. Throwing velocity in training group improved significantly (pre-test：91.10 ± 9.28kph; post-test：94.65 ± 9.65kph; p=0.005), but did not show significant change in control group (Figure 1).

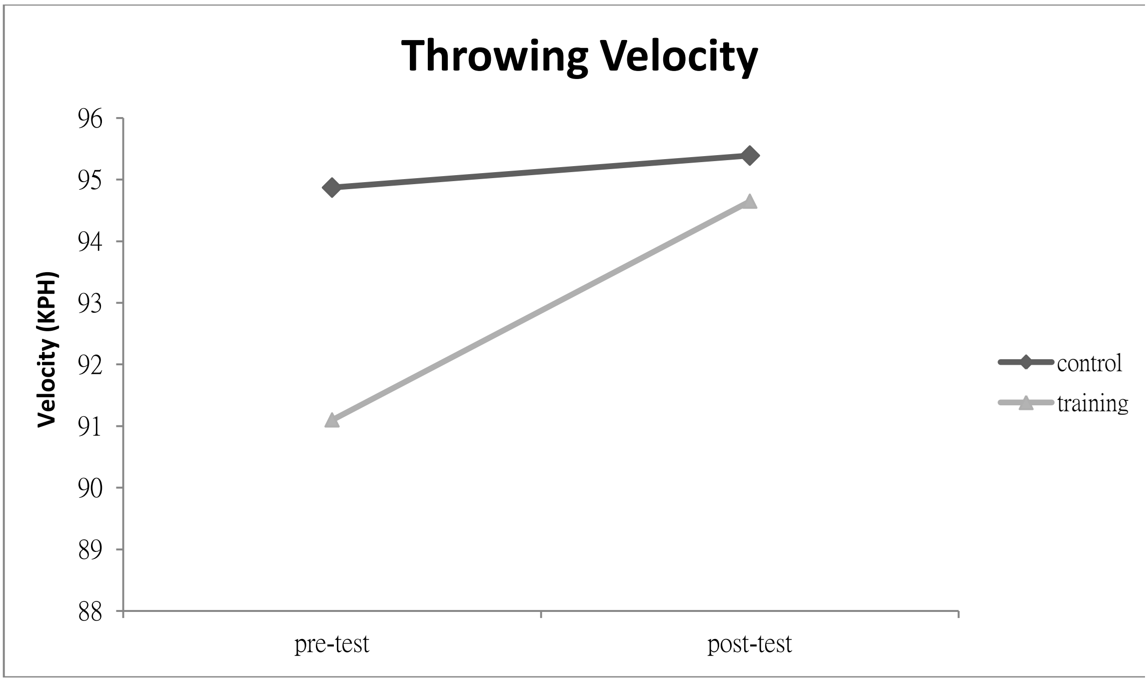

Figure 1. Throwing velocity at pre- and post-test in two groups. *: p< 0.05, significant differences between pre-test and post-test.

Throwing accuracy did not show significant difference in both groups. In throwing mechanism, only parameters of maximal angular velocity and acceleration of shoulder internal rotation (Figure 2, Figure 3)and horizontal adduction, maximal angular velocity of elbow extension and the time of occurrence of maximal angular velocity of shoulder internal rotation altered after training.

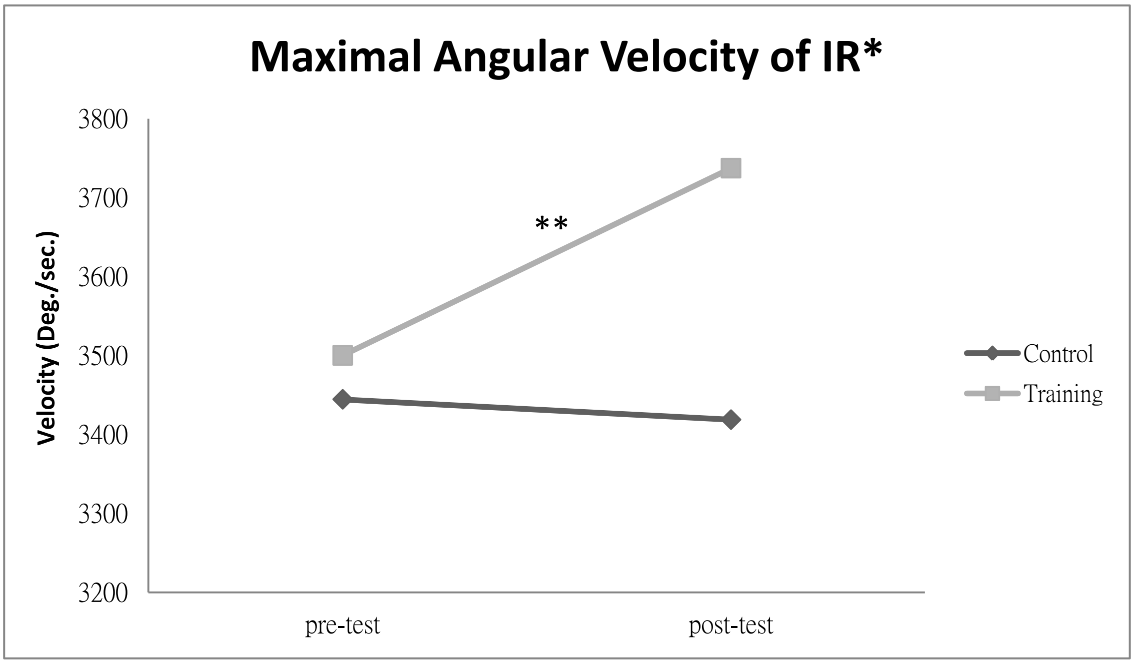

Figure 2. Maximal angular velocity of internal rotation. *: 'IR' is the abbreviation of 'internal rotation'. **: *p*<0.05, significant difference in velocity between pre-test and post-test.

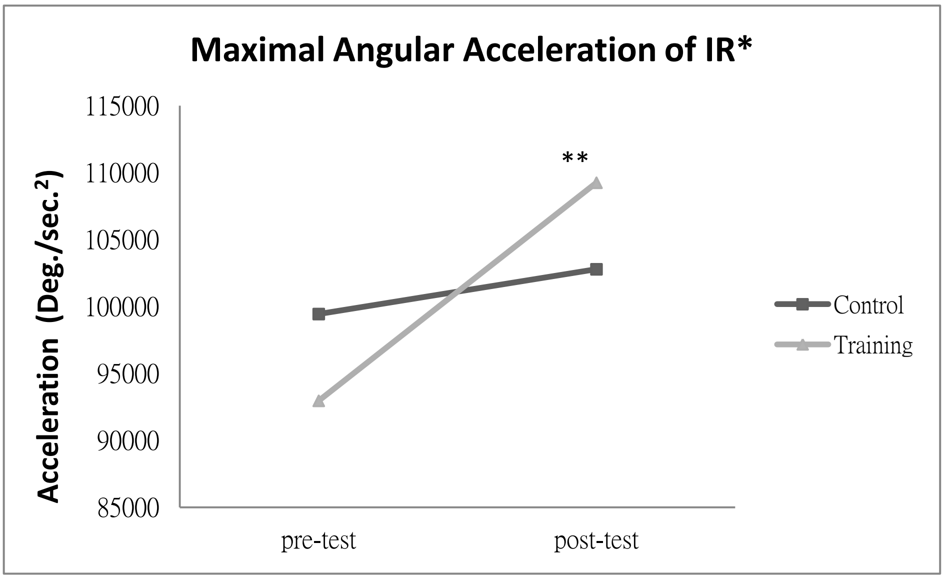

Figure 3 8: Maximal angular acceleration of internal rotation. **: significant difference between pre-test and post-test in training group. *: 'IR' is the abbreviation of 'internal rotation'

DISCUSSION: In our study muscle groups we investigated the muscle groups that play important roles in throwing. Previous researches reported that resistance training could lead to muscle hypertrophy in young men. Some studies have investigated the cross-sectional area (CSA) of training muscle. However, the CSA had been reported to be without significant change within 4 weeks of training. The results indicated that muscles did not show hypertrophy in the early stages of high-intensity resistance training. Since our study only carried out under low to moderate intensity for a short period of four weeks, it was expected to show no significant increase in muscle mass according to the findings of previous researches. Training-induced rise in strength could be caused from neural adaptation mechanisms of increased maximal motor unit firing frequency and increased excitability or reduced amounts of pre/post synaptic inhibition of spinal α motor neurons. Therefore, even though, in the present study, the training group did not show much significant improvement in muscular strengths, they did show significant improvement in the throwing performance in terms of throwing velocity.

Throwing velocity has always been one of the major parameters in judging a player's throwing performance. Our training program led to an increase of 3.55 kph (2.21 mph) in throwing velocity after four weeks. However, training effect of elastic tubes, one kind of specific resistance training, was seldom reported. Escamilla et al. designed a program involved elastic tube training with 17 exercises in a conditioning program. They reported significant improvement in throwing velocity at 2.25 mph in training groups after a four-week-training. The conditioning program included warm-up, stretching, resistance training and throwing sessions. Since we obtained nearly the same improvement as the result of Escamilla et al., we may infer that most of the improvement obtained in Escamilla et al.' s study was due to the training effect of elastic tube training protocols.

We obtained significant changes in maximal angular velocity and acceleration of internal rotation in training group after training. The results could result from the improvement of muscular strength in internal rotation. Increased muscular strength would lead to greater angular acceleration and therefore cause greater angular velocity. In pitching, angular velocity of elbow extension is more important than the angle in elbow flexion/extension. In previous study, it was reported that angular velocity of elbow extension is a factor in determining throwing velocity. In horizontal adduction, angular velocity showed the trend of increase with significant improvement of the angular acceleration in training group. Since the muscular strength did not show significant improvement, we would attribute the improvements to neural adaptation. Our results proved that the angular velocity of elbow extension increased significantly which may link to increased throwing velocity, though the angular acceleration only showed the trend of increase. In shoulder joint, maximal angular velocity of internal rotation occurred at 105% of pitching cycle (PC) which is just after ball release. In training group, occurrence of maximal angular velocity of internal rotation decreased significantly after four weeks of training. Since the time that maximal acceleration occurred did not change significantly, the decrease in time could mainly be the effect of improved strength of internal rotators leading to greater acceleration of internal rotation which coincided with our finding.

CONCLUSION: Four weeks of training only led to significant improvement in internal rotators. The main reason might be the short duration in training which only caused neural adaptation instead of muscular hypertrophy. The adaptation; nevertheless, could cause improved throwing velocity in training group. Throwing accuracy did not change significantly in both groups. We may attribute it to short duration in training and other factors affecting throwing accuracy (e.g. proprioception). Kinematics mainly changed significant in parameters of shoulder and elbow. The improved muscular strength caused improved angular velocity and acceleration of internal rotation while the increased angular acceleration also led to decreased time in reaching maximal angular velocity of internal rotation. Since the muscular strength did not improve significantly, we may attribute the improvement of maximal angular velocity and acceleration of shoulder horizontal adduction and maximal angular velocity of elbow extension to the effect of neural adaptation mechanism caused by training.

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