

THE EFFECTS OF COMBINED ELASTIC- AND FREE-WEIGHT TENSION VS. FREE-WEIGHT TENSION ON ONE-REPETITION MAXIMUM STRENGTH IN THE BENCH PRESS

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ABSTRACT

Bellar, DM, Muller, MD, Barkley, JE, Kim, C-H, Ida, K, Ryan, EJ, Bliss, MV, and Glickman, EL. The effects of combined elastic- and free-weight tension vs. free-weight tension on one-repetition maximum strength in the bench press *J Strength Cond Res* 24(x): 000–000, 2010—The present study investigated the effects of training combining elastic tension, free weights, and the bench press. Eleven college-aged men (untrained) in the bench press participated in the 13-week study. The participants were first given instructions and then practiced the bench press, followed by a one-repetition maximum (1RM) test of baseline strength. Subjects were then trained in the bench press for 3 weeks to allow for the beginning of neural adaptation. After another 1RM test, participants were assigned to 1 of 2 conditions for the next 3 weeks of training: 85% Free-Weight Tension, 15% Elastic Tension (BAND), or 100% Free-Weight Tension (STAND). After 3 weeks of training and a third 1RM max test, participants switched treatments, under which they completed the final 3 weeks of training and the fourth 1RM test. Analysis via analysis of covariance revealed a significant ($p \leq 0.05$) main effect for time and interaction effect for Treatment (BAND vs. STAND). Subsequent analysis via paired-samples *t*-test revealed the BAND condition was significantly better ($p = 0.05$) at producing raw gains in 1RM strength. (BAND 9.95 ± 3.7 kg vs. STAND 7.56 ± 2.8 kg). These results suggest that the addition of elastic tension to the bench press may be an effective method of increasing strength.

KEY WORDS resistance training, untrained, variable resistance, elastic tension

INTRODUCTION

Strength and conditioning professionals often strive to find new methods of increasing strength in traditional resistance training. Methods have run the gamut from adding chains and weight releasers to overloading the eccentric phase of the lift, to building elaborate machines that vary resistance at different points during the lift (2,5,6,7,11,12,13,16,17,25). An additional method of modifying the resistance during a traditional isotonic resistance exercise is to add elastic resistance (2,8). This method has been applied to numerous traditional lifts and has been evaluated for the bench press and the back squat (2,22). Based upon the results of these studies, it can be hypothesized that the inclusion of elastic tension to traditional resistance exercises might produce further neural adaptation that may result in increased strength. Nonetheless, it is important for researchers to test the efficacy of new training techniques as they arise, as assess the efficacy of including these new methods in training.

Recent work evaluating the efficacy of elastic tension combined with regular free-weight tension in the traditional back squat exercise suggests that the ideal split between the resistance derived from free-weight tension and elastic tension is 80–85 and 15–20%, respectively, based upon strength and power measurements (2,22). Furthermore, research performed in our laboratory has demonstrated an acute effect, using the 85% bar weight, 15% band tension on power produced after a resistance training session that combined traditional bench press with elastic tension relative to the isotonic bench press alone (4). In this experiment, 4 male collegiate shot-putters were tested for maximum power at 50% of 1RM acutely posttraining either with combined band and free-weight tension or free-weight tension alone. On the first attempt at 50% of 1RM, the post combined tension treatment resulted in significantly greater measured wattages (combined 639.0 ± 60.52 W, free weight only 556.5 ± 56.06 W). This seems to imply that the fatigue associated with combined tension is not the same as that

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incurred with free-weight bench press and does not cause as great a reduction in power. Taken together, these data provide evidence to support the idea that the 85%, 15% proportion of free weight and elastic tension, respectively, appears to be an effective combination of the 2 types of resistance.

In a recent study examining college athletes, traditional training with added elastic-band resistance produced greater gains in strength than traditional barbell training alone (2). In this study, the combined training resistance was derived 80% from free weights and 20% from elastic tension. Over the course of 7 weeks of training, participants in the combined tension group showed a 3.34-kg greater increase in 1RM bench press relative to the controls that were trained with free-weight resistance only. It should be noted that the participants from this study were college athletes who were experienced in the bench-press exercise. Given the 7-week timeframe of this study, it would appear plausible that neural adaptation might have been in part the reason for the reported gains in 1RM strength, as the 7 weeks might not have been long enough to have allowed for significant hypertrophy.

It would seem that the inclusion of elastic tension in combination with traditional resistance training has both acute and long-term effects in trained lifters. However, the efficacy of combined elastic tension training vs. the traditional free weight-only training for the bench press has yet to be evaluated in untrained lifters, the group most susceptible to neural adaptations to exercise. Therefore, the purpose of this study was to examine the strength gains accrued during resistance training with and without elastic tension in untrained individuals.

METHODS

Experimental Approach to the Problem

For the present investigation, a within-subjects design with random assignment for treatment (BAND vs. STAND) was

used. The design was chosen to counter any neural adaptation (14) that might occur because of the choice of untrained participants during the course of the study. Subjects reported to the laboratory on 23 occasions with at least 2 days between visits. After 3 weeks of standard isotonic bench-press training to allow for the beginning of neural adaptations (14), subjects were retested for 1RM and randomly assigned to training order with either 85% Free-Weight Tension, 15% Elastic Tension (BAND), or 100% Free-Weight Tension (STAND) treatment occurring in the first 3 weeks and the other treatment occurring in the second 3-week training period. The percentages for the BAND treatment were chosen after consulting the literature. All subjects trained for 3 weeks (6 sessions) with each treatment (see Figure 1). Throughout the 13 weeks, no other resistance training was performed, but subjects were permitted to maintain their previous level of activity (i.e., swimming and intramural activities).

Subjects

The present investigation was presented to the Institutional Review Board at Kent State University and approved for the use of human participants. All participants involved in the study gave written informed consent and were free to withdraw at any time. Eleven untrained, apparently healthy college-aged (23.6 ± 3.2) men volunteered to participate in the current investigation (see Table 1). A priori power analysis based upon the work of Anderson et al. (2) was used to determine the necessary sample size for adequate power (0.80). Participants were recreationally active nonsmokers who had no contraindication for physical activity. Participants had not been involved in a strength-training regimen within the previous six months and were excluded if they reported nutritional supplement use.

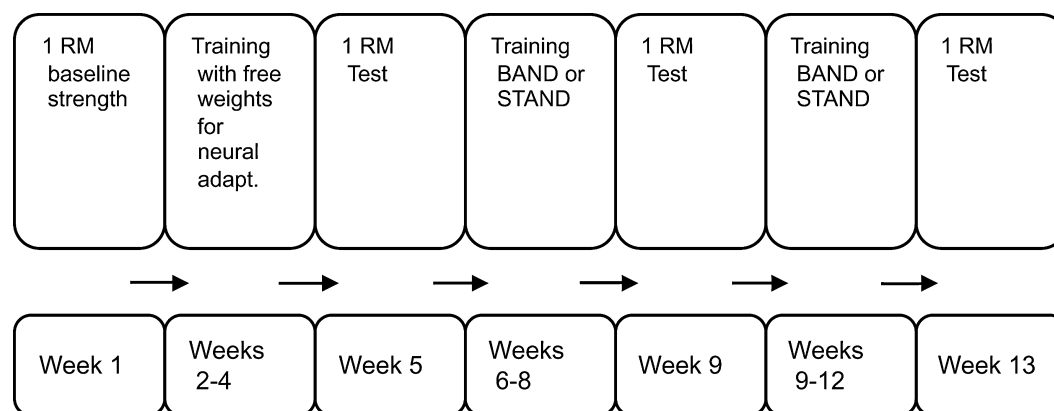


Figure 1. Timeline for protocol illustrating testing and training by week.

Procedures

Participants reported the Applied Physiology Laboratory at Kent State University for an initial visit. During this initial visit, participants read and signed consent forms and were instructed that they free to withdraw at any point during the study. Baseline anthropometric testing was performed and included height via a stadiometer (Health-O-Meter, Bedford Heights, OH) and weight via a balance beam scale (Health-O-Meter). The experimental procedures, and the correct technique for the bench press (3,21), were then explained to the subject. Participants then practiced the bench-press exercise by performing the movement with the bar only (ca. 20 kg). At this point, a neutral grip width was chosen by each participant and cataloged for use in the remainder of the protocol. After practicing the movement, the participants underwent a one-repetition max (1RM) bench-press assessment. The 1RM assessment began with a warm-up set of 5 repetitions, followed by another of 3 repetitions both with submaximal weights. Immediately after the warm-up sets, the participants began to attempt progressively heavier weights for one repetition until failure. At least 90 seconds of recovery was allowed between attempts.

All training sessions, regardless of training protocol (BAND, STAND), consisted of 5 sets of 5 repetitions at 85% of the previously achieved max with 90-second rest between sets 2 times per week. These workloads were chosen based on previous research, which demonstrated that these workloads significantly increased bench-press strength in untrained individuals (10,18,19,20). The rest interval between sets was selected to be long enough to allow for adequate recovery, equal to or greater than 90 seconds (1,23,24,25). The equipment was a standard Olympic barbell and plates (Power Systems™, Knoxville, TN). Fractional plates (Piedmont Design Associates, Maudling, SC) that were accurate to 0.10 kg were used to increase the accuracy of the 1RM determinations and subsequent training loads. The same spotter, a trained exercise physiologist, was used throughout the study to ensure safety, consistency, and successful completion of all repetitions.

Within the 2 training protocols (BAND, STAND), participants trained twice per week for 3 weeks with 5 sets of 5 repetitions with a load corresponding to 85% of the most recent 1 RM test. For STAND training, the entire 100% of the resistance used was composed of standard weight. For BAND training, 15% of the resistance used was composed of 15% elastic-band resistance (Jump-Stretch™, Youngstown, OH), and 85% was standard bar weight. The elastic modulus of each band was achieved with the help of Microsoft Excel 2000 software (Microsoft Corp., Silicon Valley, CA). Each band was hung from a stationary bar and different free weights (1.1, 2.5, 4.54 kg, etc) were added to the end of the band. The change in length was measured with an open reel tape measure and then associated with each progressive addition of weight. A plot was created of loaded weight

TABLE 1. Participant characteristics listed as mean $\pm$ SDs.

Age	Height (cm)	Weight (kg)
23.6 $\pm$ 3.2	179.5 $\pm$ 8.5	84.4 $\pm$ 18.8

(stress) vs. band length (strain). Linear regression gave the following equation for one band:

$$\text{Kilogramsoftension} = (7 \times \text{Length in meters}) - 74.58.$$

Subject arm length was measured while on the bench so that the middle of the range of motion was equal to the 85% training weight, based on the above formula. Because of similarities in subjects, only the red “mini” bands were needed during the protocol. Stretching the base blocks laterally impacted the length and tension for each subject such that no other bands were needed. Bands were retested at weeks 9 and 13 to ensure that elasticity and tension were unchanged. On weeks 1, 5, 9, and 13 subjects were tested for a 1RM using standard weight. The same method of assessment was used as that mentioned earlier in the Methods.

Statistical Analyses

Condition (BAND, STAND) by time (weeks 1, 5, 9, and 13) repeated-measures analysis of covariance (ANCOVA), covarying for treatment order (BANDS then STAND, STAND then BAND), was performed to assess changes in 1RM strength in the bench press. Covarying for treatment order was necessary because there was an odd number of subjects and because of the noted increase in 1RM over time, regardless of treatment order. The purpose of this investigation was to determine which of the 2 training protocols, BAND or STAND, elicited the greatest change in 1RM independent of the order of the conditions. Subsequent post hoc analyses for any significant main or interaction effects were performed using paired-samples *t*-tests. Statistical significance was set a priori at $\alpha \leq 0.05$. Reliability analysis performed for the dependant measure 1RM testing revealed an interclass correlation average measures value of 0.991. Statistical analyses were performed using modern statistics software (SPSS for Macintosh, Version 16.0, Chicago, IL).

RESULTS

Subject height and weight are listed in Table 1. ANCOVA (controlled for order of treatment) revealed a significant treatment by time interaction for 1RM ($p = 0.028$, $\eta_p^2 = 0.433$). Post hoc analysis demonstrated that this interaction was the result of a significantly greater ($p = 0.05$) increase in 1RM during BAND (100.0 $\pm$ 18.9 pre, 109.9 $\pm$ 19.4 post) training relative to STAND (101.5 $\pm$ 19.6

TABLE 2. Change in 1RM strength by treatment.*

Treatment	Pre (kg)	Post (kg)	Gain (kg)
BAND	100.0 ± 18.9	109.9 ± 19.4	9.95 ± 3.7*
STAND	101.5 ± 19.6	109.0 ± 20.3	7.56 ± 2.8

*1RM = one-repetition maximum.
All values as listed as mean ± SD. Gain in BAND treatment is significantly different than STAND treatment ($p = 0.05$).

pre, 109.0 ± 20.3 post) (Table 2). The BAND condition produced a 2.39-kg greater increase in 1RM relative to the STAND condition. As expected, there was also a significant main effect of time ($p \leq 0.01$) as participants significantly increased 1RM strength from weeks 1 to 13.

DISCUSSION

Although previous research by Anderson et al. (2) has demonstrated that combined elastic and free-weight training is more effective than standard free-weight training alone in athletes the present investigation was to examine the efficacy of combined elastic and free-weight training in untrained individuals. Furthermore, this was the first study to evaluate this type of training using a randomized within-subjects design during which all participants performed both standard bench-press training and elastic-band training. The advantage to the design is that, combined with the statistical control for order of treatment because of the odd number of participant, neural adaptation to the standard bench-press exercise was controlled for statistically. The current study extends the previous findings in athletes (2) to untrained college males. The demonstrated difference of 2.39 kg between the 2 treatments (combined tension vs. free weight only) in the present study was on the order of that reported in previous research (2). In previous experiments, a 3.34-kg increase between groups (combined elastic and free-weight resistance vs. free-weight resistance alone) was observed (2). Although the previous study showed greater improvements with combined elastic and free-weight resistance, participants trained for 7 weeks in this study relative to 3 weeks per type of training in the present study.

The greater increase in 1RM during the BAND condition could be because of increased tension as the joint angles in the bench press become more advantageous (9,15). Human anatomy is constructed in a manner that allows for greater force production in the bench press the farther the resistance is from the chest and that some momentum is required to transition through the sticking point (9), defined as the point in the lift with the lowest acceleration. In the combined elastic tension, free-weight condition, the bench press is modified in such a manner that it is no longer an isotonic lift.

The 15% tension that is applied to the bar through the inclusion of elastic bands is variable and based upon the elastic modulus of the band. The inclusion of an elastic-tension component changes the pattern of force production during the lift and could potentially cause further neural adaptations to occur. This is one possible mechanistic explanation for the greater increases in 1RM seen in both

athletes and untrained lifters in the bench press when training with elastic bands.

Further research evaluating the effects of combined elastic tension and free-weight tension should continue to attempt to further explore the potential neural adaptations that may be a result of the application of light band tension. The current body of knowledge that exists on this topic is limited and only includes the bench press and squat exercise. Therefore, the application of elastic tension to other lifts should be considered. Female untrained lifters should also be considered for future research with combined tension.

PRACTICAL APPLICATIONS

The present investigation has demonstrated the effects of combined elastic tension training on the bench-press exercise in untrained male lifters. This technique has been shown to be effective in increasing maximum strength in the bench-press lift for both athletes and untrained lifters alike. This information supports the potential benefits of the inclusion of combined elastic and free-weight resistance training in exercise programing that contains the bench-press exercise to maximize strength gains. It would appear that the modification of bench press to include elastic tension is an effective form of training for both athletes and untrained lifters.

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