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Review article

COMPLEX TRAINING: A BRIEF REVIEW

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ABSTRACT
The effectiveness of plyometric training is well supported by research. Complex training has gained popularity as a training strategy combining weight training and plyometric training. Anecdotal reports recommend training in this fashion in order to improve muscular power and athletic performance. Recently, several studies have examined complex training. Despite the fact that questions remain about the potential effectiveness and implementation of this type of training, results of recent studies are useful in guiding practitioners in the development and implementation of complex training programs. In some cases, research suggests that complex training has an acute ergogenic effect on upper body power and the results of acute and chronic complex training include improved jumping performance. Improved performance may require three to four minutes rest between the weight training and plyometrics sets and the use of heavy weight training loads.

Keywords: Contrast training, plyometrics, ergogenic warm-up

ÇOK PARÇALI ANTRENMAN: KISA DERLEME

ÖZET
Araştırmalar pliometrik antrenmanın yararını kuvvetli biçimde desteklemektedir. Çok parçalı antrenman ağırlık çalışması ve pliometrik antrenmanı birleştirerek bir antrenman stratejisi olarak güncellik kazanmıştır. Önceki çalışmalara dayanan raporlar, kassal. gücü ve atletik performansı geliştirmek için bu tip antrenmanı tavsiye etmektedir. Son zamanlarda, pek çok çalışma çok parçalı antrenmanı incelemiştir. Yapılan araştırmalarda bu tip antrenmanın potansiyel yararlılığı ve uygulanabilirliği hakkında cevaplanması gereken sorular varsa da, çok parçalı antrenmanın geliştirilmesi ve uygulanması için antrenörlerin yararlanabileceği sonuçlar elde edilmiştir. Araştırmalar, bazı durumlarda, çok parçalı antrenmanın üst vücut gücü üzerinde akut ergojenik etkisi olduğunu düşündürmektedir. Ayrıca, sonuçlar akut ve kronik çok parçalı antrenmanın sıçrama yeteneğini artırdığını göstermektedir. Performansın gelişmesi için ağırlık çalışması ve pliometrik setler arasında üç veya dört dakikalık dinlenmeler ve ağır kilolarla yük bindirmeleri yapmak yararlı olabilir.

ANAHTAR KELİMELER: Karşıt antrenman, pliometrik, ergojenik ısınma.

INTRODUCTION

The combination of plyometric training and weight training are thought to be useful for developing athletic power. More specifically, complex training alternates biomechanically similar high load weight training exercises with plyometric exercises, set for set, in the same workout. An example of complex training would include performing a set of squats followed by a set of jump squats. Anecdotal sources have described the application of complex training (Chu, 1998; Ebben and Blackard, 1998; Fees, 1997; Fleck and Kontor, 1986; Reddin, 1999; Roque, 1999). Previously, Ebben and Watts (1998) reviewed the complex training literature and described the effectiveness of combining weight training and plyometrics. These authors offered suggestions for designing complex training programs, and recommended further research to assess the potential effectiveness of complex training. Interestingly, recent research has examined complex training as well as the ergogenic warm-up benefits associated with weight training exercises performed prior to explosive movements such as jumping (Burger et al., 2000; Ebben et al., 2000; Evans et al., 2000; Faigenbaum et al., 1999; Jensen et al. 1999; Radcliffe and Radcliffe, 1999; Zepeda and Gonzalez, 2000). Other research has evaluated the effect of high load weight training and weightlifting exercises and their effect on explosive motor performance referring to this phenomenon as the contrast method (Young et al., 1998). The purpose of this article is to review the recent research related to complex training and the contrast method and it's potential practical application.

PLYOMETRICS AND WEIGHT TRAINING

A number of studies demonstrate the effectiveness of plyometrics compared to non-exercising control groups (Blakey and Southard, 1987; Diallo et al. 2001; Gehri et al. 1998). Other studies demonstrate an enhancement of motor performance associated with plyometric training combined with weight training or the superiority of plyometrics, compared to other methods of training (Adams et al., 1992; Clutch et al.,1983; Delecluse et al., 1995; Duke and BenEliyahu,1992; Fatourous et al., 2000; Ford et al., 1983; Lyttle et al.,1996; McLaughlin, 2001; Polhemus and Burkherdt, 1980; Potteiger et al. 1999; and Vossen et al, 2000). The evidence indicates that the combination weight training and plyometrics are effective. One way to combine the two forms of training is complex training or the contrast method. Recent studies have evaluated this type of training with mixed results.

ACUTE COMPLEX TRAINING RESEARCH-UPPER BODY

Complex training research includes acute studies as well as training studies. For example, in an attempt to quantify differences between complex and non-complex plyometric exercises, one acute study compared electromyographic (EMG) and kinetic variables, such as ground reaction forces, associated with the medicine ball power drop performed before and following a set of 3-5 RM bench press. More specifically, subjects performed the power drop exercise lying supine on a bench press bench that was mounted to a force platform. Subjects caught and forcefully threw the ball upward with horizontal flexion/adduction of the shoulders and extension of the elbow in a movement that is similar to the bench press with the exception that the medicine ball is projected into free space. Results from this study revealed no significant difference for mean or maximum ground reaction force and integrated EMG for the muscles evaluated in each power drop condition. In other words, the medicine ball power drop performed in the complex training condition was equally effective, but not superior, in eliciting motor unit activation or force output compared to the same exercise performed before the 3-5RM bench press set in the non-complex condition (Ebben et al., 2000). A similar study, using female subjects resulted in the same findings of no significant differences between the complex and non-complex training groups (Jensen et al., 1999).

Other research has examined the complex training effect of combined bench press and medicine ball throws demonstrating improve plyometric performance in the complex condition. More specifically, one study sought to determine whether or not upper body power could be enhanced by performing a heavy bench press set prior to an explosive medicine ball put. Subjects included 10 college age males with experience performing the bench press. Subjects performed a seated medicine ball put before and four minutes after performing the bench press with a 5RM load. Results indicate a significant increase medicine ball put distance of 31.4 cm (no standard deviation available) following the 5RM bench press compared to the medicine ball put before the bench press. Researchers also report a strong correlation between improvement in medicine ball put distance and 5RM bench press strength (Evans et al., 2000).

ACUTE RESEARCH-LOWER BODY

Research has also examined the effect of complex training while combining total body or lower body strength/power exercises and some form of jumping. For example, Radcliffe and Radcliffe (1999) examined the "warm-up" effect of the power snatch, backsquat, loaded jumps and tuck jumps on the performance of the horizontal countermovement jump. Results reveal that when all subjects were combined, no significant warm-up effect existed. When male subjects were analyzed separately, however, the jump distance was greater when performed after the snatch as a weightlifting warm-up. This study used a three-minute rest protocol between sets. This data demonstrates that for males, specific weightlifting exercises may have an ergogenic effect on a subsequent set of jumps.

Additional evidence supporting a potential acute complex training effect is demonstrated in a study by Young et al. (1998), who evaluated whether or not loaded counter movement jumps (LCMJ) could be enhanced if proceeded by a set of five repetition maximum (5 RM) half squats. Subjects performed two sets of five LCMJ, one set of 5 RM half squats, and one set of five LCMJ with four minutes rest between all sets. The jump height for the LCMJ after the squat was 40.0 cm ±3.5cm compared to a pre-squat jump height of 39.0 ± 3.3 cm, resulting in a 2.8% improvement in jump performance. The authors indicate that there was a significant correlation between the 5 RM load and jump performance. Results suggest that for complex training, a high load weight training exercise performed four minutes before a power exercise increased the performance of the power exercise, especially for stronger individuals.

TRAINING STUDIES

Training studies have also been conducted to examine the effectiveness of complex training. For example, one study compared the effects of strength training and complex training in boys and girls (8.1 ± 1.6 years). Results demonstrate that children attain similar gains in upper-body strength and endurance using either strength or complex training programs (Faigenbaum et al., 1999).

In addition to studies using children as subjects, other training studies examined the effects of a three-week complex training program with seven division I college female basketball players. Pre and post test results reveal improvement in the 300 m shuttle, 1 mile run, VO2 max, 20 yd dash, pro agility run and the t-test, reverse leg press and back squat. The data show that the complex training program was effective in eliciting statistically significant improvement in the 300-meter shuttle. However, the research design does not appear to have evaluated the effectiveness of non-complex training combinations of plyometrics and weight training or used a control group (Zepeda and Gonzalez, 2000).

In another training study evaluating complex training, Burger et al. (2000) examined the effectiveness of a complex training group compared to a group who performed all of the weight training exercises after the plyometric exercises. Each group performed the same 7 week routine except the complex training group performed the plyometric exercises in a superset with biomechanically similar resistance training exercises, whereas the other group performed the plyometric exercises separately, following the resistance training exercises. Subjects included seventy-eight division I college football players. Subjects were pre and post-tested with a variety of tests including percentage of body fat, bench press, squat, power clean, medicine ball throw, broad jump, vertical jump and the I test. Both groups demonstrated improvement in all eight of the tests. However, the complex training group demonstrated significant between group vertical jump improvement (2.8 cm) compared to the non-complex training group (0.1cm).

ANALYSIS OF COMPLEX TRAINING STUDIES

These recent studies represent the vast majority of research conducted on complex training. Previously, Ebben and Watts (1998) reviewed the research on various combinations of weight training and plyometric training as well as complex training. At that time, despite numerous brief references to complex training in the literature, only one training study specifically examined complex training. The results from that study were difficult to interpret, however, due to the absence of published numerical data (Verkhoshansky and Tetyan, 1973). According to Ebben and Watts (1998), complex training program design must consider important variables such as exercise selection, load, and rest between sets. Recent research offers additional guidelines regarding these variables and raises the question about age and gender specific effects as well.

Recent acute studies suggest that complex training may be effective for upper (Evans et al., 2000) and lower body training (Radcliffe and Radcliffe, 1999) and may be more effective for males (Radcliffe and Radcliffe, 1999). Additionally, prerequisite strength and the intensity of the load (RM) used in the weight training portion of the complex may be important in eliciting a complex training effect during the plyometric condition (Young et al. 1998). Recent research also suggests that three to four minutes of rest between the weight training and plyometric training portions of the complex may be optimal (Evans et al, 2000; Radcliffe and Radcliffe et al. 1999; Young et al., 1998). Ultimately, even the study that demonstrated no advantage associated with performing power drops after the bench press showed that performing plyometrics in complex training is at least as effective as performing them in a non-complex fashion (Ebben et al., 2000).

Recent complex training studies that examined the effect of complex training for children and female athletes suggests that complex training was equally as effective, but not superior to other strength training programs (Faigenbaum et al., 1999; Zepeda and Gonzalez, 2000). This finding may be consistent with the idea that prerequisite strength is necessary for complex training to be most effective and that this type of training may be best suited for those who are highly trained (Ebben and Watts, 1998).

In contrast, the effectiveness of complex training was demonstrated in part, with male division I college football players. In this case, researchers found that the complex training group demonstrated significant between group vertical jump improvement Burger et al., (2000). The vertical jump performance improvement associated with complex training is consistent with the purported role of complex training as an effective training strategy for improving power (Ebben and Watts, 1998). Evidence suggests that jumping ability seems to demonstrate an acute improvement in response to complex training stimulus according to the findings of Young et al. (1998) as well as improving as a result of a chronic complex training stimulus (Burger et al., 2000).

CONCLUSION

Anecdotal observations, publications, and conference presentations on the topic suggest complex training is an area of interest for conditioning professionals. Empirically minded professionals have responded with data to guide the application of complex training. Minimally, complex training can be an efficient way to organize combined weight training and plyometric training since both types of training can be performed during the same session in the same facility. Additionally, research suggests that complex training is at least equally effective, and in some cases superior, when compared to other forms of combined weight and plyometric training as evidenced by increased medicine ball throwing power, superior acute jump performance, and improved vertical jump in response to a chronic complex training stimulus.

Recent research suggests that it may be necessary to allow three or four minutes rest between the weight training and plyometric conditions. Finally, these data demonstrate a possible relationship between strength and plyometric performance in the complex suggesting that this training strategy may best be suited for more highly trained individuals using RM loads in the weight training portion of the complex. Future research should examine the effects of the specific type of exercises employed, age, gender, training status and load/intensity on complex training.

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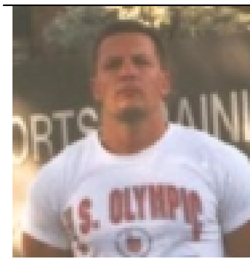

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