Practical Guidelines and Considerations for the Use of Elastic Bands in Strength and Conditioning

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ABSTRACT

ELASTIC BANDS ARE A FORM OF VARIABLE RESISTANCE AND A STRENGTH TRAINING MODALITY COMMONLY SEEN WITHIN A STRENGTH AND CONDITIONING TRAINING ENVIRONMENT. THEY ARE CONSIDERED AN EFFECTIVE TRAINING TOOL DUE TO THE FACT THAT THE RESISTANCE ALIGNS WITH THE FORCE CAPABILITY OF THE MUSCULATURE THROUGHOUT THE RANGE OF MOTION OF MANY MOVEMENT TASKS. THIS ARTICLE WILL EXPLORE THE WAYS IN WHICH ELASTIC BANDS CAN BE USED TO CHALLENGE OR ACCOMMODATE A MOVEMENT'S RANGE OF MOTION TO PROVIDE A MORE SPECIFIC STRENGTH-TRAINING STIMULUS. FOR A VIDEO ABSTRACT OF THIS ARTICLE, SEE **SUPPLEMENTAL DIGITAL CONTENT 1** (SEE VIDEO, HTTP://LINKS.LWW.COM/SCJ/A146).

INTRODUCTION

The power-producing capability of an athlete is often considered the key performance indicator for successful sports performance. Strength and conditioning specialists use a variety of methods to enhance the production of human power (13). Resistance training is commonly used to develop and enhance athletes' ability to produce force, a major contributor to athletes' ability to produce power. In brief, there are 3 modes of resistance training: constant external resistance, accommodating resistance, and variable resistance (VR). Constant resistance is where the external load is unchanged throughout the full range of motion and is the most popular form of resistance training (28).

Accommodating resistance (also termed isokinetic resistance) allows the muscle to contract maximally while the velocity is controlled (28). VR aligns with the force capabilities of the muscle throughout a given range of motion (22). According to Zander, VR training has been around for over a century, dating back to 1870s when Nautilus weight machines were designed to accommodate the human strength curve (34), which relates to the scientific model of varying force capabilities at different joint angles (22). More recently, VR elastic bands have been used within the sport and health professions to enhance proprioceptive motor control (1,2,6,24,29). In addition, elastic bands have become increasingly more popular as a performance enhancement tool and subsequently have been investigated systematically to better understand the mechanisms responsible for the performance adaptations that have been observed (1–3,6,7,16–19). However, despite the empirical attention elastic bands have received, surprisingly, little information is available detailing the various ways elastic bands may be used within a strength and conditioning environment. Therefore, the objective of this article is to provide the reader with some practical methods for using elastic bands (Figure 1) to challenge or assist a movement's range of motion for the purpose of enhancing muscular power as well as provide examples of how elastic bands may be used to enhance an individual's kinesthetic awareness.

THE MECHANICAL ADVANTAGES OF USING ELASTIC BANDS

AS A RESISTIVE MODALITY

Elastic bands can challenge or assist the human strength curve by providing

KEY WORDS:
variable resistance; elastic bands; accommodating strength curve

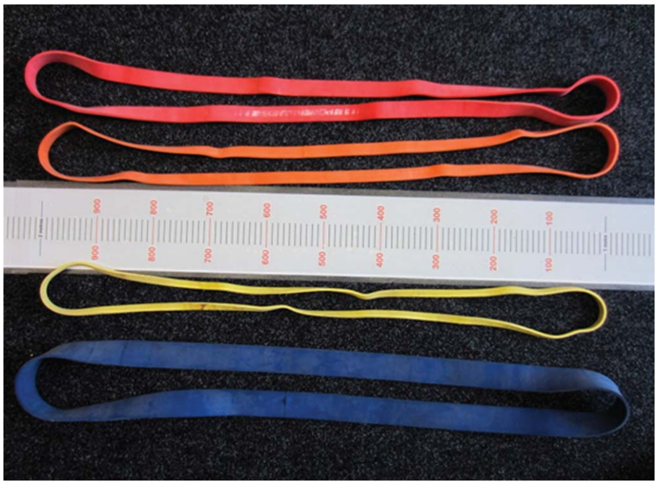

Figure 1. Sample of elastic bands commonly used by strength and conditioning coaches (supplied by Iron Woody strength band, Inc.).

variation in how a muscle complex is challenged over a range of motion (7,18,33). There are several concepts that have been reported in the literature for why elastics bands may be a benefit for enhancing the power capability of an athlete. Advocates of using elastics bands purport that they can assist with enhancing the force and/or acceleration capability of muscle to a greater degree than free weights alone.

To understand why proponents of elastic bands favor this training modality, it is important to consider that the human strength curve is influenced by the torque (relationship between force and joint angle) about single joints using 2- or 3-dimensional coordinate systems (12). The human strength curve, as described above, can be classified into 3 categories: ascending, descending, and bell shaped (Figure 2) (20,22). The shape of the curve is determined by the neuromuscular force angle relationship (22). An example of exercises influenced by a descending curve where maximum strength is required at the end of the concentric phase are upper-body pulling movement tasks such as the bent over row, chin-ups, and bench row (11).

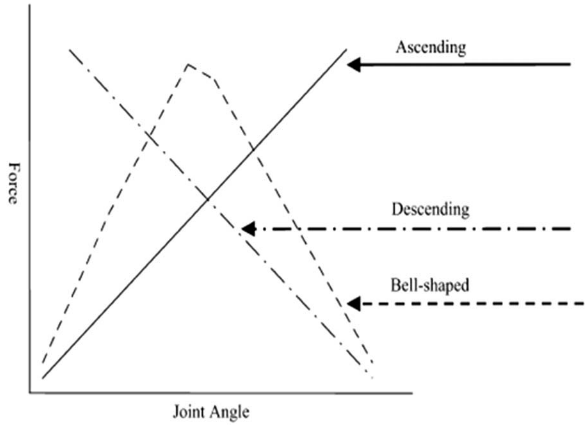

Figure 2. An illustration of the 3 classified human strength curves (adapted with permission from McMaster DT, Cronin J, and Mcguigan MR, Forms of variable resistance training. *Strength Cond J* 31: 50–64, 2009. Adapted by permission of Lippincott, Williams, and Wilkins.

Single-joint movements such as bicep curls or leg extensions are examples of bell-shaped strength curve exercises where maximum strength occurs around the middle of the movement's range of motion (11). Finally, movement tasks such as a squatting, deadlifting, and/or weightlifting movement tasks are examples of an ascending strength curve (11). Human movement is empowered by the summation of the multijoint torques allowing humans to lift heavier loads at or near full limb extension (4).

The fact that training with elastic bands aims to challenge the ascending strength curve by providing a variable load throughout a range of motion with the most resistance experienced at or near full muscular extension where humans typically exhibit the highest force production capability is a primary reason why elastic bands in combination with constant resistance may be superior over constant resistance alone (2,7,18). The limitations of using constant resistance or free weight all the time in training is the fact that the load is unchanged throughout the movement's range of motion. This is important to understand when you consider the mechanical properties of muscle, specifically how muscles are mechanically disadvantaged at certain positions within a movement task due to the length tension principle. Constant resistance may not adequately challenge the musculature at the point in a range where the greatest loads can be lifted (10). Rather the musculature is limited at the point in a range where it is weakest (i.e., the sticking point).

However, elastic bands used in conjunction with free weights may provide the strength and conditioning professional with an opportunity to challenge a range of motion while mitigating the effects of a movement's "sticking point." Elastic bands used as a resistive modality compliment the length-tension relationship by requiring a progressive recruitment in high-threshold motor units, thus, requiring the highest motor unit recruitment at the most mechanically advantageous position within that movement (12,16,22,23). Figure 3 illustrates that

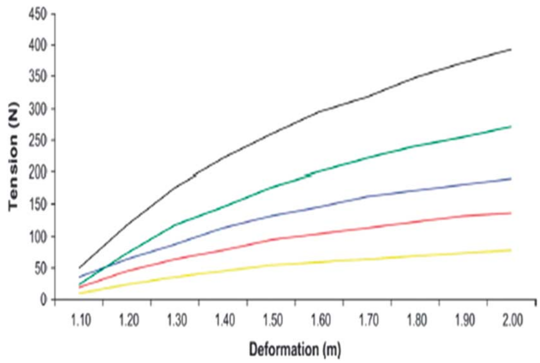

Figure 3. An increase in elastic band deformation results in a curvilinear increase in tension.

with an increase in deformation of elastic bands, there is a curvilinear increase in the load experienced by the musculature (22).

Furthermore, an increase in motor unit recruitment is generally reflected by enhanced muscle activation during both the eccentric and concentric phases of a movement (7,13,32). The increase in muscle activation levels may attribute to the unique neuromuscular stimulus achieved with elastic bands (1–3). Although some authors have failed to show an increase in muscle activation using elastic bands, this is not consistent with the majority of elastic band research, and it is therefore unclear to the authors if methodological issues confounded the results of the aforementioned study (9).

Figure 4. Illustration of the stack setup for elastic force profile in the resisted modality.

In addition, training with elastic bands can challenge the athlete's ability to accelerate a load through a given range of motion. This is in contrast to free weight training alone due to the fact that the force required to get a free weight load moving is not the same force that is required to keep it moving due to momentum the system mass incurs. The greater the elastic band to free weight load will influence the amount of momentum the system will incur. When you consider that the contractile element of muscle is enhanced by high contractile speeds and the acceleration of any object is proportional to the force required to move that object and inversely proportional to its mass or inertia, elastic bands could be a more appropriate modality for developing the velocity capability of muscle. A practical example would be that the beginning of the concentric phase of a barbell squat where the load is created using free weight and elastic bands, the total system load experienced by the athlete will be less, thus allowing the athlete to achieve higher accelerations early in the movement. As the elastic bands stretch, the athlete is required to continue recruitment of high threshold motor units resulting in an increase in force production at higher speeds, which will likely translate to greater power production at or near full limb extension (1,13).

A further consideration for the use of elastic bands to enhance an athlete's ability to produce power is the benefit elastic bands have at assisting with the development and enhancement of an athlete's rate of force development (RFD). RFD is often considered the key performance indicator in power-based sports. Yet, there are many athletes that struggle to express their strength in a short period of time. For sports such as sprinting, when contact

Figure 5. Illustration of the setup for measuring the actual force applied by the elastic band in the resisted setup.

times are less than 0.3 seconds (29), some authors report contact durations closer to 0.1–0.2 seconds (14,25,27). There is a dearth of research that has investigated the influence of elastic bands on developing or enhancing RFD. However, the research that has specifically investigated the influence of elastic bands used in training on the RFD capability of an individual has shown improvements in RFD after using elastic bands (25,29,33). Several mechanisms have been suggested for why elastic bands may improve RFD, namely, a longer peak velocity phase, an exploitation of the stretch-shortening cycle, and the increase in elastic energy storage within the soft tissue structures that support human movement (15,33).

Figure 6. Illustration of the stack setup for elastic force profile in the assisted modality.

Finally, improvements in eccentric strength is a feature of any progressive resistance training program and if trained purposefully can result in an increase in maximum strength, as measured by a 1 repetition maximum (1RM) test (8,30). As elastic bands are a product of their own elastic properties, there is the potential for an increased eccentric loading. This potential is 2-fold: (a) the elastic properties increasing the eccentric loading by "pulling" on the load and (b) the necessity to slow and stop the barbell at the end of the eccentric phase (7). Additionally, at the beginning of the movement, the elasticity increases, thus enhancing velocity of the eccentric phase, which can provide a greater eccentric stimulus from the stored elastic energy (5), in turn contributing to increases in the required force production during the subsequent concentric phase (7). Collation of scientific and anecdotal research for resisting protocols indicate that the total unit load may be between 60 and 85% of an athlete's 1RM, of which 20–30% of this total load is mass provided by elastic band tension (22).

AS AN ASSISTIVE MODALITY

There are a few studies that have been conducted investigating the effect of using elastic bands to assist a movement through a given range of motion (2,21,31). The results of these studies have reported greater power and velocity outputs, potentially by a mechanism known as "overspeed." Two reported benefits of using elastic bands to assist a movement are an increased shortening rate and increased neuromuscular system activation (26,31). Practice-

Figure 7. Illustration of the setup for measuring the actual force deducted by the elastic band in the assisted setup.

based evidence has used elastic bands with high loads to attenuate the force required at mechanically weak parts of a movement; for example, assisting a heavy back squat so that the load at the bottom of the squat is less. This may be desirable during periods of heavy sport competition when athletes may be feeling more fatigued or in an over-speed training phase where speed of movement is the training objective and the strength coach may not want the athlete to be limited by their speed at the bottom of a movement.

Newton et el. (25) concluded that assisting a movement task allowed the athlete to "explode" out of the bottom of a squat, which in turn would increase specificity and translate to sporting movements like jumping or ballistic nature movements. Further practice-based evidence has reported the use of elastic bands as a corrective exercise or rehabilitation modality. Where by the elastic bands may be used to attenuate a bodyweight load to enable athletes with poor movement competency to use traditional movements like push-ups, pull-ups, and/or single leg squats to learn how to use their body in more a functional manner (Figures 8–12), or to attenuate impact forces associated with plyometric training to allow higher training volumes required in a rehabilitation phase.

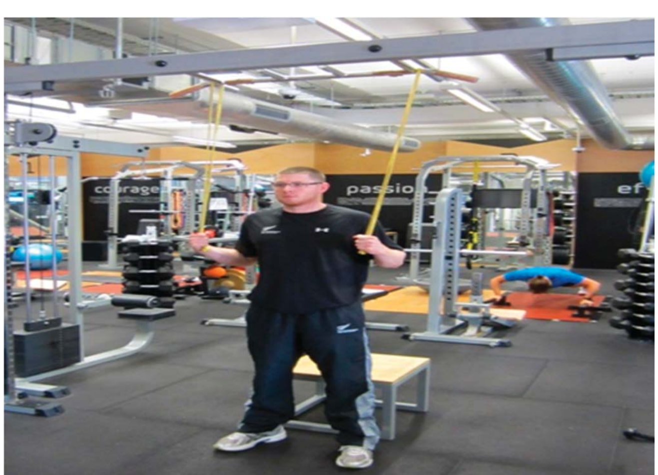

Figure 8. Band-assisted bodyweight box squat.

GUIDELINES FOR SETTING UP ELASTIC BANDS FOR RESISTANCE OR ASSISTANCE

RESISTANCE SETUP

Figure 5 illustrates the triangular attachment between a barbell and power rack used by the authors for performing elastic-resisted exercises. Other methods such as that seen in McMaster et al. (21) are achievable, yet, the aforementioned triangular attachment will be the focus of this article. It is strongly recommended regardless which method is used to attach the elastic bands, that the load is quantified to accurately prescribed training loads based on an athlete's capabilities. The method of quantifying the elastic force used by the authors is detailed below:

A known mass (including a 20-kg barbell) was placed on top of a plyometrics box, which in turn is on a forceplate (PASCO Pasport 2-Axis Force Platform–Ps-2142) (Figure 4). The force provided by this "stack" was recorded. The height of the stack was

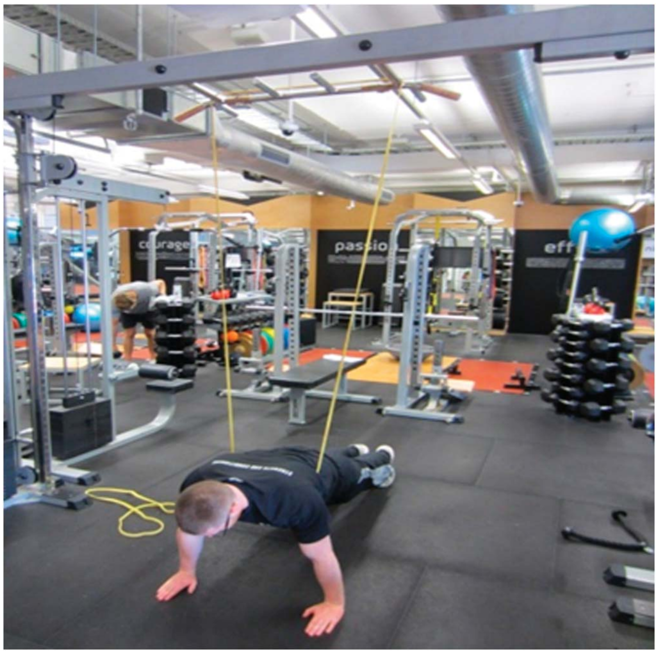

Figure 9. Band-assisted bodyweight press-up.

then adjusted to correspond to different pin placements on the squat rack. A range of elastic bands (Figure 1) were set up in a triangular fashion as in Figure 4 and attached to the barbell (Figure 5). This "total force" was then recorded for all elastic bands at different heights on the squat rack. The "stack force" was subtracted from the "total force," giving an elastic force contribution for different stretch deformations. This process was repeated for different selected heights that corresponded to pin placements on the squat rack to create an elastic force profile.

ASSISTANCE SETUP

The elastic band attachment to the barbell and power rack is illustrated in Figure 7. The stack setup is similar to the resisted force profile; however, the bar is loaded with a weight that resists elastic force at any stretch deformation (Figure 6). The stack force was then recorded. Each individual elastic band was then attached to the barbell that corresponded to different pin heights on the squat rack through the attachment as shown in Figure 7. The total force was then recoded and subtracted from the stack force.

EXERCISE

There are a number of ways elastic bands can be used to provide VR either through resisting and assisting. These elastic bands can be used as an introduction to basic compound exercises to teach proper eccentric to concentric control and stabilization. Illustrated below (Figures 8–12) are some examples for each fundamental movement pattern including their starting and midpoint positions. These examples can be applied to other exercises such as lunges, pull-ups, and bench pressing. In addition, elastic bands may be used to teach an athlete how to use their body to better express power. For example, fixing elastic bands around an athlete's hips as shown in Figure 12 requires them to emphasize hip extension to complete the movement task with good muscular tension. Hip extension has been reported to be an important segmental requirement during ground-based movement tasks involving the kinetic chain-like sprinting and jumping (18).

PRACTICAL APPLICATIONS

Training with elastic bands can be used to assist the training of novice to elite level athletes. For novice and/or weaker athletes, elastic bands can be

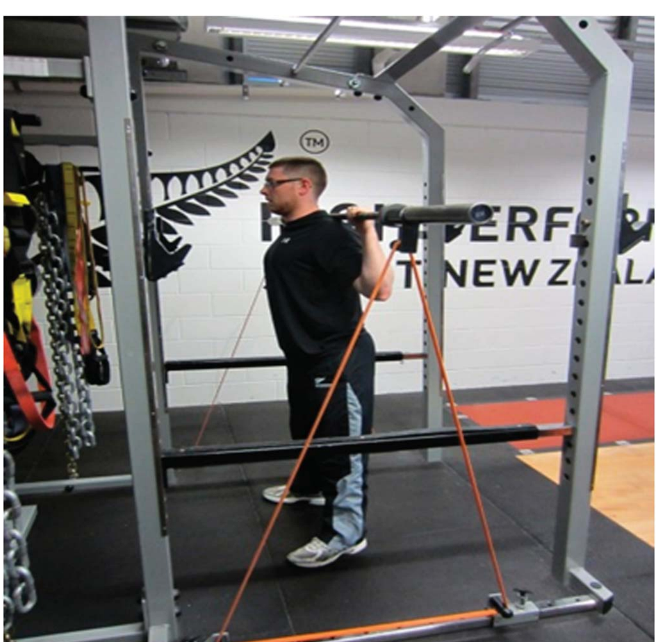

Figure 10. Band-resisted squat.

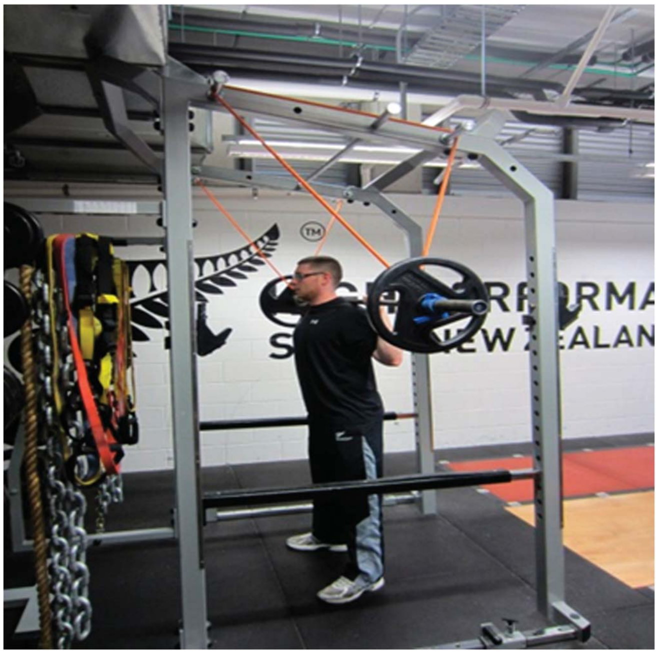

Figure 11. Band-assisted loaded squat.

used to attenuate bodyweight or external loads through sticking points, so control and stability can be accomplished throughout a movement task's range of motion. For intermediate- or advanced-level athletes, resistance bands can be used in a resisted or assisted manner to enhance force production, velocity of movement, and subsequent production of mechanical power. The Table highlights a sample program demonstrating how elastic bands may be used as a resistive and assistive modality within the same training phase through the course of a training week and periodized across a training block.

In the Table, the authors provide a sample program highlighting the integration of elastic bands for an in-season strength program for an elite rugby 7s. The authors believe that challenging the force production capabilities should be at the beginning of the week when the player is at their freshest and the total accumulated training/game loading is at its lowest, therefore allowing the athlete to express greatest force production. The assisting modality is placed toward the end of the week 2 days before their respective game. This acts as a peaking strategy and a means of aiding recovery by (a) reducing the overall system load (including central nervous system loading) and (b) allowing the player to exert the velocity side of the power equation. The progression across the weeks is to allow for continual development of the mechanisms related to each of the modalities; hence, the increasing percentage of total load as a result of the elastic band, which increases the utilization of the mechanisms gained through elastic bands and not through traditional resistance training.

CONCLUSIONS

The use of elastic bands may offer the strength and conditioning coach an opportunity to exploit a range of mechanisms that cannot be provided through traditional resistance training. The practicality of elastic bands allow accommodating resistance to be applied in both a resisting and assisting fashion to accommodate the development of force and velocity characteristics and thus enhance athlete's power production capabilities. The diversity of elastic bands can also be used as a learning tool for novice athletes in enhancing and understanding motor

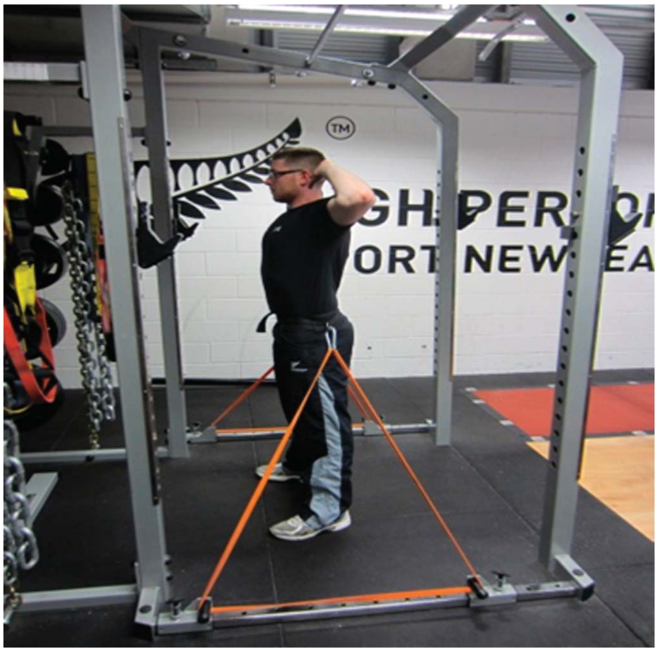

Figure 12. Band-resisted hip extension.

Table
An example of resistance training program for an elite rugby 7s player using both assisted and resisted modalities

Session 1	Session 2
Week 1	
Resisted 5 × 5 at 80–85% 1RM (10% total load from elastic bands)	Assisted 5 × 3 at 80–85% 1RM (10% total load from elastic bands)
Week 2	
Resisted 5 × 5 at 80–85% 1RM (20% total load from elastic bands)	Assisted 4 × 3 at 80–85% 1RM (20% total load from elastic bands)
Week 3	
Resisted 5 × 5 at 80–85% 1RM (30% total load from elastic bands)	Assisted 3 × 3 at 80–85% 1RM (30% total load from elastic bands)

1RM = 1 repetition maximum.

control in numerous traditional resistance exercises.

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