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Periodization of Strength Part 3: Max Strength Phase

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The main objective of the Maximum Strength (MxS) phase of training is to develop the highest level of force possible. Most sports require either power (long jump), muscular endurance (800 to 1000m swimming) or both (rowing, canoeing, wrestling and team sports). The level of MxS affects each of these types of strength. For example, without a high level of MxS, power cannot reach high levels. Since power is the product of speed and MxS, it is logical to first develop MxS and then convert it to power.

MxS training plays an important role in creating sport-specific strength. As the need for maximum strength increases, so does the length of the MxS phase of training. An athlete's ability to increase maximum strength depends on the diameter of the cross-sectional area of muscle involved, the capacity to recruit fast-twitch muscle fibers and the ability to synchronize all the muscles involved in the action.

Muscle size depends greatly on the duration of the hypertrophy phase, whereas the diameter of myosin and the increase in protein content in the form of cross-bridges depends on the volume and duration of the MxS phase. The capacity to recruit fast-twitch muscle fibers depends on the use of maximum strength loads and explosive power movements. MxS training represents the only means of activating the powerful fast-twitch motor units.

Strength improves as a result of creating high tension in the muscle, which is directly related to the training method employed. An athlete does not have to increase body weight as a function of MxS training. Sports such as volleyball and basketball do not require a large muscle mass; however rely on an enormous amount of maximum strength for performance. Similarly, boxers and martial arts competitors require maximal strength, while an increase in muscle size or weight can actually hinder performance outcome. The ability to increase maximal strength without a concomitant increase in muscle weight has lead to characterizing the MxS phase of training as "Nervous System" training.

MxS training improves links with the CNS thus promoting both the improvement in inter-muscular coordination (i.e. activation of synergists and co-contraction of antagonists) and intra-muscular co-ordination (i.e. recruitment and firing rate of motor units, reflex response and motor unit synchronization).

Unfortunately, very little is known about the involvement of the nervous system in MxS. Small amounts of empirical evidence and large amounts of anecdotal evidence collected from coaches, trainers and athletes' claim that MxS training represents the most beneficial method of improving levels of strength.

THE MAXIMUM LOAD METHOD

Absolute strength is defined as the greatest amount of weight an athlete can lift in a specified movement irrespective of body weight. Relative strength is defined as the highest amount of weight an athlete can lift and is expressed as a function of body mass. In other words, adding to the latter point, athletes who desire an increase in maximum strength in the absence of greater body weight, require an increase in relative strength. The following discussion will provide methods of improving relative strength that can be applied during the maximum strength phase of training.

The maximum load method (MLM) is probably the most determinant factor in developing sport-specific strength. The MLM positively influences speed-power dominant sports by increasing the myosin diameter of the fast-twitch muscle fibers and recruiting more fast-twitch motor units. The MLM method can result in MxS gains that are up to three times greater than the proportional gain in muscle hypertrophy. Although increases in muscle size are possible for athletes who are just starting to use the MLM, they are less visible for athletes with a longer training background. As stated in Bompa (1999), the improvement of MxS using maximum loads has the following advantages;

· Increases in motor unit activation, resulting in high recruitment of fast-twitch muscle fibers.

· It represents the determinant factor in increasing power output. As such, it has a high neural output for sports where speed and power are dominant.

· It improves both inter-muscular and intra-muscular co-ordination.

· Because it results in minimal increases in hypertrophy, it is extremely important and favorable in sports where relative strength is crucial**.**

PROGRAM DESIGN

The MLM should only be implemented in a training program after the athlete has completed at least 2 to 3 years of moderate general strength training. In other words, the athlete's program should have been filtered around the loads inherent in AA and HYP training methods. Highly trained athletes with 3 to 4 years of MLM training are so well adapted to such training that they are able to recruit some 85 percent of their fast-twitch muscle fibers. The remaining 15 percent represent a latent reserve that is not easily tapped through training.

Creating the highest tension possible in the muscle develops MxS. According to the size principle, motor units are recruited according to size beginning with the recruitment of the slow-twitch followed by the fast-twitch motor units. Therefore, in order to recruit the powerful fast-twitch motor units, loads greater than 85 percent are required. The MLM employs 3 to 5 exercises that particularly involve the prime movers. Plan training sessions with the highest amount of sets that the athlete can tolerate ranging from 8 to 12. Exercises should be ordered by use of the vertical method, which alternates muscle groups and facilities local muscle recovery between sets. The suggested number of repetitions is 1 - 4 per set and 15 - 18 per exercise per session. The athlete's classification, training background and training phase, along with the number of exercises employed in training will determine the number of repetitions performed per exercise.

A 3 to 6 minute rest interval between sets is recommended given that MLM training involves the CNS, which takes longer to recover. A shorter rest interval will jeopardize the power of the nerve impulse to the muscle fiber and negatively impact the restoration of ATP/CP. On the same line, due to the high demand placed on the neuromuscular system, MLM training should take place no more than 2 to 3 times per week. The speed of contraction plays a very important role in MLM training. To achieve explosive force, the athlete must concentrate on activating the muscles as quickly as possible. However, due to the heavy load, the movement will appear slow. Only a high speed of contraction performed against a maximum load will quickly recruit the fast-twitch fibers resulting in increased maximum strength. Behm and Sale (1993) have demonstrated that slow-velocity strength similar to maximum strength training can improve high-velocity strength by virtue that the athlete attempts to move the weight as quickly as possible. Suggested training parameters for the MLM are stated below in Table 6.2.

Table 6.2 Training Parameters for the MLM

Training Parameters Work
Duration of Phase 3-4 weeks
Load 85-100 %
of exercises 3-5
of reps per set 1-4
of sets per exercise 3-6 (8)
of sets per session 15-30 (40)
Rest interval 3-6 minutes
Speed of execution fast (attempted)
Frequency per week 2-3 (4)

Bompa, 1999

THE ECCENTRIC METHOD

Numerous studies have accounted the relative mechanical, metabolic and neural stimuli differences between concentric and eccentric contractions. Results illustrate that while maximal concentric contractions lead to maximal muscle activation, maximal eccentric contractions do not appear to elicit complete muscle activation. In other words, an athlete must work with heavier loads during the

eccentric phase in order to foster a positive adaptation in strength. The neural command for eccentric contractions is unique in that it decides: (1) which motor units should be activated; (2) how much they have to be activated; (3) when they should be activated; and (4) how the activity should be distributed within a group of muscles.

Since the Eccentric Method employs extremely heavy loads (110 to 160 %1RM), it is suggested that only athletes with 3 to 5 years of strength training background use this method. The Eccentric Method can be used alone in a training session, in a short training phase, or can be combined with other methods of maximum strength training. It is recommended however that the Eccentric Method be used only when further gains are no longer produced from the MLM. Supra-maximum loads can be very dangerous, so it extremely advisable that two spotters are used when an athlete performs such movements. The athlete may wish to complete 1 to 2 sets using the MLM and the last set via the eccentric method. Similar to the MLM, exercises should be isolated to involve the prime movers used in the sport. One session per week is recommended for the eccentric method. The speed of execution should be relatively slow since the athlete is employing loads far beyond the concentric strength. Furthermore, it is recommended that at the breaking point of the eccentric phase of the movement, the athlete attempts to lift the load concentrically. While such a task is utterly impossible, the brief isometric contraction may stimulate an increase in motor unit recruitment patterns, firing frequencies and rate of force development (Behm and Sale, 1993) beyond the degree that could be obtained by a maximal concentric contraction. Table 6.4 lists the suggested training parameters to follow when utilizing the Eccentric Method in the training program.

Table 6.4 Training Parameters for the Eccentric Method

Training Parameters Work
Load 110-160%
of exercises 3-5
of reps per set 1-4
of sets per exercise 4-6 (8)
of sets per session 20-36
Rest interval 3-6 minutes
Speed of execution slow
Frequency per week 1

Bompa, 1999

A well-planned and executed MxS phase of training can foster great increases in both absolute and relative strength levels. It is crucial that athletes and coaches use caution when implementing a MxS phase since loads used in training have been known to cause injury. An athlete must be anatomically prepared before undergoing a MxS phase. Once a high level of maximum strength has been developed, an athlete is physiologically prepared to further develop power or muscular endurance. The next article in this series will address the development of maximum strength into power.

REFERENCES

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