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METHOD – RELATED PRINCIPLES OF STRENGTH CONDITIONING FOR ATTAINING POSITIVE TRANSFER OF TRAINING

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ABSTRACT

The aim of the current study was to analyse the method – related principles of applying different means of strength training and correspondence to attaining positive transfer of training. We applied a logical – analytical approach that is based on different concepts of strength conditioning, documented experience of elite athletes, and coaches and internationally published research data. Experience gained by top coaches and research prove that the development of strength abilities has to begin with developing muscle elasticity and inter-muscular coordination, followed by the influencing of intramuscular coordination, with the main focus on increasing the maximal muscle strength on account of hypertrophy or fast innervations. The logical sequences of developing strength abilities in annual training cycle recommended by different authors provide thought – provoking ideas for programming appropriate training patterns, bearing in mind the general principles of the transfer of training.

Keywords: *training transfer, fundamental sequences in strength training, unilateral strength exercises, muscle elasticity*

INTRODUCTION

In the training of several sports the strength-enhancing preparation is essential. It has to be conducted with maximum efficiency in order to guarantee the transfer of training. In other words, strength exercises have to be selected and performed in a way that their effect is favourably transferred to the final aim – competition exercise. Depending on the sport event, the final aim of the strength-enhancing preparation can vary, in the most general terms it is either endurance or speed-oriented. In both cases it is necessary to plan the efficient developing sequence of strength conditioning core exercises and different strength types, and further their association with other exercises. Proceeding from the requirements of elite sport, the focus is set at the dominant abilities and the securing of the integral qualities of the training process and positive transfer of training. Taking into account the basic mechanisms of transfer of training should contribute to the efficient management of the training process. The aim of the current study was to analyse the methods-related principles of applying different means of strength training, and correspondence to attaining positive transfer of training. We applied a logical-analytical approach that is based on different concepts of strength conditioning, documented experience of elite athletes and coaches, and internationally published research data.

Factors influencing the training transfer

The conversion of training exercises into sport performance is called transfer of training [14]. This transfer takes place when three equivalent demands have been met: internal structure of movement, external structure of movement and generation of energy [3]. Central to the concept of transfer is the well-accepted training principle of specificity, which states that adaptations are specific to the nature of training exercises. Beginner athletes can achieve good transfer from general training exercises, whereas experienced athletes attain specific adaptations [1]. The essence of concept of transfer of training and its scientific-empirical treatment is covered in great detail in a monograph published by Bondarchuk [2]. He advises the new classification of the exercises, both relevant and consistent with the concept of transfer of training;

1. Exercises for general development
2. Exercises for specialized preparation
3. Exercises for specialized development
4. Competition exercises

This classification foresees the preferred application of specialized training means throughout the multiyear preparation aimed at elite sport. In this approach, general development means are used in small volumes only for warm-up and in recovery activities. Exercises for specialized preparation and specialized development create a basis for enhancing performance of the competition movements at each stage or period of the training programme. Their transfer effect depends, first of all, on their similarity with the competition activity and higher training potential.

Training transfer as a process

When examining training transfer mechanisms, Bondarchuk [2] concludes that the transfer level of physical activities achieved at the end of each stage of training is a result of the process occurring throughout the whole stage, ensuring a new adaptation level for the exercises to be used during the following stages. Transfer of training is only possible in case the aim is to develop a good performance during the training year and the succession of applied training exercises leads to specialized developmental exercises – consequently, if there is no succession to these exercises there will be no transfer either. In case of the described structure of training process an athlete will be acquiring the sporting condition in the course of all training periods, and the final outcome is the competition result. This type of training transfer is called "current" (vs "distant") transfer. Current transfer is simpler, as the organism's systems are freed from different orientating reactions. It is necessary that the training potential of the applied programme is increased continuously. Improvement of performance is the main criterion of adaptation efficiency. This is in accordance with the findings of Neumann et al. [7] according to which training is effective if its main components are linked to create a constant influence spiral that can be visualized in the form of a cone, with the base of good basic preparation and the apex of competition-specific preparation and the expected competition performance. This helps to understand training activities and the progress of adaptation as a constant process. It is also possible to regard strength training in the form of a cone or pyramid, the base of which consists of developing muscle and strength endurance and general strength with orientation towards muscular hypertrophy. The apex of the pyramid comprises exercises requiring a high level of innervations (maximal, fast and explosive strength).

Typical fundamental sequences in strength training

When estimating the efficiency of adaptation processes it has to be considered that the higher the energetical potential of the cell, the better are the possibilities to intensify protein synthesis following strength training. Therefore, it is logical that a training macrocycle starts with increasing the energetic potential of muscles. A typical basic sequence in a macrocycle is: muscle endurance → strength endurance → general strength → maximal strength → speed strength and explosive strength (the applied terminology has been compiled by Hirvonen and Aura) [5]. The types of strength gradually increase in their intensity and specific effect: the previous type of strength creates the morpho-functional basis to obtain the greatest effectiveness of the subsequent type of strength and the latter completes the training of the previous type of strength at a higher functional level. This logical sequence ensures good training transfer due to similar elements between its single links.

The development of strength over time can be distributed into three phases [3]: first, the increase in strength can be attributed to an improvement in inter-muscular coordination; second, there is an improvement in intramuscular coordination and third, an increase in strength results from hypertrophy. These recommendations are in good accordance with Young's [13] finding that considerable gain in power output in intramuscular coordination of non-specific movements can be accompanied by small changes in sport performance. Research on neural adaptations to resistance training indicates that inter-muscular coordination is an important component in achieving transfer to sports skills.

Methods-related principles in the management of strength training

In order to be efficient and achieve positive transfer of training, all strength training components have to be encompassed in one system. The management of the system can be viewed as rearrangement of system elements and logical developmental sequences according to objective biological and pedagogical principles. In strength training adaptation are used energy supplies and reserve of proteins and amino acids of the whole organism. The dominant system can be structurally secured preferentially, in other words, at the expense of other systems. The sequence of adaptation changes has to be considered when planning a training programme. Each type of load has a more intensive and specific effect and gradually takes the place of the previous load. This logical sequence is likely to ensure good training transfer due to similar elements in single links.

Bilateral or unilateral strength exercises

Squats and jump squats on both legs are popular exercises for training strength and power and have also been used in training studies. High-resistance weight training of leg-extensor muscles is effective for improving maximal strength in a squat, but this has not transferred to sprint speed [4, 12]. The poor transfer of power training could relate to a lack of movement specificity to sprinting, involving unilateral contractions to leg extensors resulting in total horizontal body movement. For this reason asymmetrical strength training [15] of one-leg squats has been recommended for track and field athletes many years ago. There are three stages in this training system:

1. Stage 1 – strength. Additional added weight 3–5 kg. 6–8 squats in one series, 5–7 series, 5–10-s rest between series
2. Stage 2 – speed strength. Squats by metronome 55–65 times in one minute without additional added weight, 35–40 times in one minute with additional added weight of 5–10 kg
3. Stage 3 – jumping ability. Jumps performed by one foot for power or speed development

This approach may yield a good transfer to performance but can also produce positive outcome, avoiding overtraining, muscle imbalance, and increased injury risk.

Applying plyometric exercises

Some plyometric exercises can be transferred to sprinting and this reflects the specificity of contraction velocity. Bounding exercises have been found to possess ground-contact times similar to sprint running [10]. A well-known Canadian coach MacFarlane [9] has also recommended the system of horizontal and vertical jumps. A typical basic developmental sequence in a macrocycle of sprinters and hurdlers is: long horizontal jumps (duration 10 s and more) → short horizontal jumps (standing long jump, triple jump) → short vertical jumps (jump over hurdles) → drop jump (up to 1 m height).

In this system the athlete begins with increasing the energetic potential of muscle and each type of load creates favourable conditions for increase in training intensity and specificity, and gradual passage from special strength preparation to specific competition speed occurrs.

Role of elasticity

Elasticity plays an essential role in enhancing motor output in sport movement. If a muscle shortens immediately after stretch, force and power output are increased and energy expenditure is decreased [14]. This stretch–shortening cycle is a common element of several sport skills. Since reversible muscle action is an element of the majority of movements in sports, it has to be learned and trained specially. For example, running is a series of bounces during which muscles, tendons and ligaments alternately store and release the absorbed energy, as the feet hit the ground. There is growing evidence to suggest that the elastic recoil provided by the tendons, ligaments and collagens contributes a significant proportion (about 30%) of the energy propulsion when running on flat terrain [8]. It is possible that economical runners have a greater ability either to store or utilize this form of impact energy.

Muscle strength vs elasticity

Although strength abilities are closely connected to elasticity abilities, excess strength training is harmful in many contexts. First, the usually applied maximal strength exercises are in terms of coordination very far from the conditions in which muscles work during the main sports event. Secondly, surplus muscle mass increase and excessively fast increase in maximal strength has never been considered an asset in endurance and jumping events [13]. However, in many training programmes the "pumping" of muscle strength takes up the majority of training time, although connective tissue elements are affected only indirectly. Tendons and ligaments are weak and not ready to stand up to the anticipatory development of muscles, and injuries and other negative deviations may occur. Without performing specific exercises, first tendons and ligaments weaken and their elasticity properties decrease. Developing tendons and ligaments requires a considerably longer period of time than developing muscle mass. Therefore, when training the children the connective tissue elements have to be developed first followed by muscle mass development. Bosch and Klomp`s [3] methods-related approach according to which the development of strength abilities has to begin with developing inter-muscular coordination is also favourable from the point of view of muscle elasticity since preferably low and medium loads are applied to induce the influence of a longer duration. According to Zatsiorsky [14], maximal muscular strength and forces produced in fast reversible action are not correlated in good athletes and should be trained as separate motor abilities. Performance in drop jumps for example, is not improved as a result of strength exercising, even with heavy weights. In qualified athletes, elasticity skill is very specific.

The development of muscle elasticity

The system of Romanov [11] for the development of muscle elasticity deserves special attention. The system's characteristic feature is that all jumping exercises are performed in S-type pose, where legs are slightly bent at knees and other joints. The idea is that this pose maintains tendons and ligaments in an elastic state like in fast-running animals. All jumps have to be performed using the front part of foot arch. In jumping exercises the main attention should be paid to muscle which is rapidly pulling the leg off the ground – *iliopsoas* muscle and *rectus femoris* muscle. Only one sharp contraction impulse, followed by rapid relaxation and a fast ground contact time is achieved. These exercises can be grouped as follows:

1. Jumps on the same spot
2. Forward jumps in different directions
3. Jumps using light additional weights

This sequence can be used both for teaching the exercises and also for developing muscle elasticity, ensuring the gradual increase in difficulty, where the initial focus on muscle elasticity is followed by additional muscle strength development. There are many examples of successful application of muscle elasticity in modern elite sport. The Olympic Champion and World Record holder in decathlon Asthon Eaton is an excellent model here. The results that he has shown are impressive, first of all in events requiring speed, speed endurance and endurance: 100 m, 110 m hurdles, 400 m and 1500 m. Asthon Eaton possesses a close-to-ideal muscle elasticity properties, excellent relaxation skills and well-coordinated movements – these characteristics can be easily observed by everyone, not just coaches or athletics specialists. One can speculate whether the key to his success has been the balanced development of strength and muscle elasticity in the long-term training process, or the preferred development of muscle elasticity. Very pragmatic exposition of the training carried out by World Record holder in triple jump Jonathan Edwards revealed [6] that the key to his success was elastic strength development. The basic elements of training were the balanced development of maximal strength and power and specific endurance bounding plus circuit exercises and jumping sessions. The fast running rhythm and extraordinary endurance and economy in African distance runners is probably not possible without high level of muscle elasticity.

CONCLUSION

The development of strength abilities is a controversial process. In elite sport, one has to guarantee the coordinated development and optimal connecting of leg muscles connective tissue elements and muscles. Research results and experience gained by top coaches prove that the development of strength abilities has to begin with developing muscle elasticity and inter-muscular coordination, followed by the influencing of intramuscular coordination, with the main focus on increasing the maximal muscle strength on account of hypertrophy or fast innervations. Excessive maximal strength increase can be evidently accompanied by emergence of dominant excitation centers in the brain that can set off negative effects when quick and well-coordinated movements have to be performed. For securing increasing force-generation capacities and speed qualities in modern sport, it is essential to influence the complexes of structural and enzymatic proteins in muscles and elastic properties in muscles and connective tissue elements. The logical sequences of developing strength abilities in annual training cycle recommended by different authors provide thought-provoking ideas for programming appropriate training patterns, bearing in mind the general principles of the transfer of training. Further research in this area could open new perspectives and help to improve the management of training process considerably.

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