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**TOPIC NO. 3
Strength**

**Lecture - 177
Strength:
Concept, Types, Factors, Methods and Management
of
strength training programme.**

Introduction

Training is the process of preparation for some task. "Sports training is a pedagogical process, based on scientific principles, aiming at preparing sportsman for higher performances in sports competition".

Sports training is also essential to understand the meaning of the terms 'conditioning' and 'coaching'. Conditioning is a process of gradually preparing the body for strenuous physical activity thus focusing attention on development of physical and motor fitness components (strength, endurance, speed, flexibility, co-ordinative abilities) and directly enhancing sports performance.

Concept

Strength has been considered as the most important conditional ability. It has been the most significant factor to enhance sports techniques and performance. Development of strength also contributes to indirect development of other conditional abilities namely speed and endurance. Since all sports movements are created by the contraction of muscles, therefore, strength is an important component of various conditional abilities, skills and tactical actions. Strength and strength training, therefore, assume high performance for achieving good performance in all sports. The role of strength training for general health, good posture and for prevention of injuries is usually overlooked

which in the long run can prove harmful. Zimmermann (1989) has very rightly pointed out the positive effects of strength training on muscle bones, joints, heart, circulatory system, metabolism and nervous system.

Strength is the ability to overcome resistance or to act against resistance. Strength should not be considered a product of only muscular contractions. It is, in fact, a product of voluntary muscle contractions caused by the neuro-muscular system.

Types of Strength

In sports movements, strength always appears in some combination with the duration and speed of movement i.e., in combination with endurance and speed abilities. In each sports movement strength appears in a different form. Strength can be classified into the following three types:

1. Maximum Strength

It is the ability to overcome the maximal possible resistance. It is measured by finding out the maximum resistance which can be overcome or the maximum force which can be applied by the muscles. The maximum strength is a motor ability and involves force application during a voluntary movement. The muscles normally are capable of generating higher magnitudes of force if stimulated electrically. The electrical stimulation causes maximal contraction of all motor units in a muscle which normally cannot be achieved voluntarily except under extreme emotional state of fear, anger etc.

The force values achieved through electrical stimulation are indicators of biological capacity of the neuro-muscular system for strength application. It is called absolute strength. (Singh 1984, Hartmann and Tunneman 1986)

Maximum strength is not important in majority of the sports. It is important only in those sports in which very heavy resistances have to be tackled e.g., weight lifting, throws etc. In many sports, however, there are phases of movement when the muscles, must apply maximal or near maximal force e.g., cross position on roman rings, start and acceleration phase in sprints, take off in jumps. In such sports maximum strength is important. The importance of maximum strength lies in the fact that in majority of the sports it serves as the basis for good explosive strength and strength endurance.

Ability to overcome the maximal possible resistance.

Intensity	:90-100% rep
Repetition	:1-3
Recovery	:full (3 min)
Set	:3-10

The best examples are weight lifting and throwing events (shot, discus and hammer throws in track and field)

2. Explosive Strength

It is a combination of strength and speed abilities. It can be defined as the ability to overcome the resistance with high speed. Depending on the nature of combination of strength and speed, the explosive strength can be further divided into start strength, strength speed (power) and speed strength. Start strength, is the ability to develop maximal muscle force during the starting phase of the movement e.g., sprint start, weight lifting etc. Strength speed is the ability to overcome heavy resistances with high speed e.g., throws, jumps etc. Speed strength is the ability to overcome lower resistances with high speed e.g., team games, combat sports (lower weight categories). The explosive strength is of different nature in cyclic and acyclic movements. (e.g., power)

Explosive strength always finds expression in motor movements i.e., it is a form of dynamic strength. Explosive strength performances are markedly influenced by the level of motor-co-ordination required for a movement e.g., inter and intra muscular co-ordination. As a result explosive strength is highly specific to the nature of a movement and for its development, specific movements (or part of these movements) have to be used as exercises.

A high percentage of movements in sports is of explosive nature and involves overcoming of some external resistance or of one's own body weight. Explosive strength, therefore is important in most of the sports. Even in endurance sports, explosive strength is important for start as well as 'spurt' phases.

Ability to overcome resistance with high speed.

Intensity	: 80-90% rep
Repetition	: 4-8
Recovery	: 90-180 sec
Set	: 3-6

The best examples are sprints, jumps, smashing in volleyball, hitting in hockey etc.

3. Strength Endurance

Like explosive strength it is also a product of two motor abilities. . It is the ability to overcome the resistance longer time under the condition of fatigue. Strength endurance can be a form of static (iso-metric) or dynamic (iso-tonic) strength depending on the fact whether the movement is static or dynamic. Depending on the nature of the combination of strength and endurance the strength endurance can be further classified into proper strength endurance and endurance strength. Strength endurance is the ability to overcome high resistance or to act against high resistance under conditions of fatigue e.g., in combat sports, long duration events requiring strength e.g., Pole Vault. Endurance strength is needed for activities in which low resistances are to be tackled e.g., Swimming, Road cycling etc.

In all sports movements whether fast or slow, movements have to be done under lesser or higher conditions of fatigue. Even for sprints some amount of strength endurance is required in last phase or in heats. Strength endurance, therefore, is important in most of the sports.

Ability to overcome the resistance longer time under the condition of fatigue.

Intensity	: 40-60% rep
Repetition	: more than 12
Recovery	: 60-90 sec
Set	: 3-6

The best examples are long distance races in track and field, swimming, distance cycling, wrestling, boxing etc.

Factors determining Strength

Strength is a highly trainable motor ability. Before taking up a discussion of the means and methods for improving strength, it is essential to know the factors on which strength depends. This will help us in understanding the nature of strength as well as the proper and effective formulation of strength training. The important factors which determine strength are given below:

a. Physiological cross-section of the muscle

The muscle cross section indicates the size of the muscle. As a result of regular strength training, the diameter of a muscle increases (hypertrophy) and it becomes capable of producing more strength. It is an accepted fact that bigger and larger muscle can generate more force. The force which can be generated by one square centimeter of muscle ranges from about 6-10 kp. This is nearly the same in males and females. Men, however, are stronger because they have much larger muscle mass as compared to women. Strength can be increased by increasing the muscle cross section (hypertrophy) through appropriate means and methods of strengthening. In women high muscle hypertrophy is not possible due to the lower level of male sex hormones. The misconception that women will get big muscles due to strength training, therefore, is not scientifically tenable.

b. Morphology of the muscle

The muscles consist of muscle fibres which are basically of two types fast twitch fibres (white fibres) and slow twitch fibres (red fibres). The fast twitch fibres can contract faster and can produce more force. On the contrary slow twitch fibres take more time to contract but these can keep contracting for a longer duration. The fast twitch fibres can hypertrophy much more than the slow twitch fibres. The muscles which have a high percentage of fast twitch muscle fibres, therefore, can produce more strength. The size of such muscle can also be considerably increased through strength training. The proportion of these two types of muscle fibres is largely genetically determined and cannot be changed through training or by some other means. The muscle fibres spectrum, however,

has a wide range of variation from muscle to muscle and from individual to individual. The persons who have muscles with favourable muscle fibre spectrum, therefore, have better strength ability and trainability for strength.

c. Co-ordination of muscles that participate in the movement

The level of strength is markedly affected by co-ordination. In every movement, two groups of muscles are involved i.e. agonist and antagonist. When the agonist contracts, the antagonist should completely relax. This co-ordination between the two can result in greater amount of strength. The role of co-ordination in strength performance can be discussed from the three levels of co-ordination involved in tackling or overcoming a resistance.

i. Skill

The process of overcoming or acting against resistance involves some type of movement involving muscles of more than one body part. The best results are achieved if this movement is done skillfully. The skill can be acquired through motor learning and as a result the strength performance is one of the main topics of interest of sports bio-mechanics.

ii. Inter muscular co-ordination

Refers to the proper and dynamic co-ordination between different muscles and muscle groups (muscle synergy) which are contracting to overcome resistance.

iii. Intra-muscular co-ordination

Refers to the co-ordination among different motor units within a muscle. A muscle can contract with greater force if all the contracting motor units (whether slow twitch motor units) contract in a manner which enables greater force production.

d. Phosphogen stores in the body

The ultimate source for muscle contraction is the rate and amount of energy supply through chemical reactions taking place in the muscles. Muscle needs energy for contraction, which comes from the breakdown of phosphogens (ATP and CP). Greater the phosphogen store in the body, higher will be the production of energy for contraction of muscles. The rate and amount of energy supply can be improved through training.

e. Body weight

A person with higher body weight is generally considered stronger than the lighter persons. This is particularly true in case of trained sportsmen. The positive relationship between body weight and strength can be partly explained by the larger muscle mass of bigger and heavier persons. The other reasons for complete understanding of this relationship, however, are not clear. Perhaps greater mass of bones, connective tissues and, possibly also, fat tissues is essential to support large muscles. All this results in more body weight.

f. Psychic factors

Psychological factors, namely motivation, emotion, anger, aggression etc., have direct bearing on strength performance. It has been proved that psychic factors limit the individual's capacity to fully utilize his strength capacity or potential. A fully aroused state of mind with the determination to apply maximum force results in a very strong nerve impulse leading to activation of larger number of motor units. The trained sportsmen are able to push their psychological limits to a significant extent.

Other factors

Strength is also influenced to a lesser or greater extent by the following factors:

1. Physique and body composition.
2. Length of the muscle at the time of contraction.
3. Strength and stability of the musculo-skeletal system.
4. Bio-mechanical factors like leverage and angle of pull.

Methods of strength training

Weight training and many other form of resistance exercises (using gadgets other than barbells and weight plates) are effective means of developing different forms of strength. The intensity, density, duration and repetitions have to be so planned that exercises contribution to development of different types of strength. For resistance exercises, movements can be performed against ones own weight, weight of the partner, and even weight jackets, wrist and ankle collars can be used to increase resistance. Medicine ball exercises, rubber cables exercises, harness running and different forms of partner exercises can be performed to improve strength. Utilising the four forms of muscle constructions namely Isotonic, Isometric, Eccentric and Isokinetic, different methods of strength training are planned. Variations are made of intensity, repetitions, number of sets and recovery between sets and series so that different forms of strength can be trained. For developing maximum strength, intensity is high and repetitions are less, for explosive strength, intensity is sub-maximum and repetitions are performed as fast as possible and for training strength endurance, intensity is medium and several repetitions are performed. For maximum and explosive strength, recovery is complete between sets whereas for developing strength endurance the recovery phase between two sets is short. In order to avoid injuries, good warming up prior to strength training is of good significance. The coach should explain all the important precautions to be taken to prevent injuries. Spine of the body is the most injury prone area. In all strength training exercises, the spine should be kept erect at all times. In the beginning stages, spotters may be used while working with barbells. The popular methods of strength training are:

1. Simple Method / System

This method is recommended for the beginners. A simple schedule of 6 to 8 exercises is developed so as to cover all major muscle groups of the body. 3x8 repetitions of each exercise are performed. The exercises should be so arranged that each main muscle group is exercised in turn e.g., a leg exercise can be followed by one designed to promote strength in either the arms or the trunk. In this method exercises are not performed in a circuit method. Required number of repetitions and sets of each exercise are completed before proceeding to the next exercise. Variations in intensity, repetitions, sets and recovery can be done to develop different forms of strength.

2. Combination Method / System

This method is most suited for developing strength endurance. This system is not all recommended for maximum strength development. Combined method differs from simple method in terms of recovery to be provided between various sets. Progressive resistance technique (PRT) can be very effectively implemented in this method.

Using the same 6 to 8 strength training exercises, as for the simple system, exercises 1 and 2 are combined, as are 3 and 4, 5 and 6 and ultimately 7 and 8. The sportsperson performs one set of eight repetitions of exercise 1 and immediately switches over to exercise 2. After performing eight repetitions of exercise 2, one returns back to exercise 1 until three sets of 8 repetitions of both exercises are completed. The recovery period which the first muscle group gets is the time for which exercise 2 is performed.

3. Super Set Method / System

This method is most suited for development of maximum strength. However, it can also be used for training other forms of strength. Since this approach places stress on high intensity workouts, it is not recommended for beginners. This system is similar to combination method in all respects except categorization of exercises. Two arm or leg exercises are combined in such a way so that the flexor and extensor muscles are trained one after the other. Between the set for developing flexor and extensor muscles, no recovery is provided.

Examples of a schedule of six strength training exercises:

1. Sit ups
2. Back Hyperextension
3. Half squat
4. Leg Curl from supine position
5. Arm Curls
6. French Press.

Three sets, each of 6 to 8 repetitions, are performed.

4. Pyramid Method or System

This method is best for developing maximum strength. In this system any strength training exercise is chosen and in each set 3 to 5 repetitions are performed with maximum load. A good warm up session is an important pre-requisite for this method. Example:

- 1 set of three repetitions with a load of 90% = 90%X3 by 1
- 1 set of two repetitions with a load of 95% = 95%X2 by 1
- 1 set of one repetitions with a load of 100% = 100%X1 by 1
- 1 set of two repetitions with a load of 95% = 95%X2 by 1
- 1 set of three repetitions with a load of 90% = 90%X3 by 1

5. Plyometrics or Reactive Method

This method is effective for development of explosive strength. This system involves stretch-shortening cycle of the muscle. The following exercises are done:

a. Hopping

Initially all movements are done with both legs together and hopping is done on the spot. The height of the hop gradually increased. In each set 15 to 25 repetitions are performed. Between sets full recovery is provided. In all three sets are recommended. For advanced sportspersons, single leg hopping is recommended in 3 sets of 10 repetitions with full recovery rest intervals between sets.

b. Bounding

This exercise involves alternate hopping and stepping. 3 to 5 sets, each of about 20 repetitions are performed. Between sets full recovery is provided. Standing hops and jumps, with different combinations of hops and jumps can be performed. 5 sets of 6 to 8 repetitions are performed. Between sets full recovery is provided.

c. Depth jumps

This method involves jumping down from a height of 40 to 120cms and then jump forward for distance or jump up for height. 3 to 5 sets, is of 10 repetitions are done. Full recovery between two sets is provided. Initially all movements should be done with both feet and gradually with increase in strength, jumps with one leg can be performed. For jumping, boxes and benches of varying height can be used. In order to prevent injuries, the landing should be done on the toes. Heels should not touch the ground. While landing after executing a jump from a height, one must land with knee angle of about 120 degree to 140 degree and should give in upto 90 degree-100degree i.e., the optimum range of bending is 30 degree- 50 degree. In as much as this method is very strenuous, it is recommended only for highly conditioned sportspersons. Some coaches are of the opinion that this procedure leads to knee and ankle injuries and also produces soreness and stiffness in the leg muscles. However, if planned properly after thorough warming up possibilities of injuries can be avoided.

Circuit Training

Circuit training is an effective method of developing strength endurance. A circuit of 6 to 10 exercises is arranged in such a way that different muscle groups are exercised at different stations. The performer moves from one station to another and undertakes load and recovery in the following two ways i.e.,

- (a) 30 seconds exercise and 30 seconds rest between two stations.
- (b) 20 seconds exercise and 40 seconds rest between two stations.

Some of the examples are:

- a. Sand running for distance runners.
- b. Up- hill and down-hill running for sprinters.
- c. Running against head wind for runners.
- d. Swimming against water current.
- e. Cycling against head wind.
- f. Playing on loose surface.
- g. Smashing in volleyball with wrist collars.
- h. Playing football with weight jackets.
- i. Wrestling against a heavier partner.

Management of strength training programme

Effective management of strength training deals with actual performance of strength training in a training unit (training schedule). For proper management, two important points are to be kept in mind. They are –

- I. Procedure of arrangement of strength training exercises.
- II. Procedure of administering strength training load during a training session.

1. Procedure of Arrangement of Strength Training Exercises

Three procedures are adopted:

- (i) Simple Training System (Station Training).
- (ii) Set Training System.
- (iii) Circuit Training System.

2. Procedure for Administering Training Load

This procedure involves amount of resistance and the number of repetition of an exercise. The important loading procedures are as follows:

- (i) Fixed resistance and fixed repetitions
- (ii) Increasing resistance and fixed repetitions
- (iii) Varying resistance and fixed repetitions
- (iv) Reducing resistance and fixed repetitions

(v) Contrast method

In this system of strength development sets are performed in such a way that the high and low resistance alternate. The resistance is increased in steps over period of weeks e.g., 60%, 20%, 80%, 35%, 80%, 40%.

Conclusion

Strength is an important component of various conditional abilities, skill and tactical actions. Exercises involving competitive movement and done with additional weights e.g. hurdling with weight jacket on, kicking in soccer with ankle weight collars on etc. This method is good for improving technique. It is effective for developing speed of movement and endurance. This method involves stretch-shortening (the muscle first stretches against resistance and then contracted maximally) cycle of the muscle.