Chapter IX

FLEXIBILITY

Flexibility is a motor ability which is not clearly a conditional or a co-ordinative ability. It depends partly on energy liberation processes and partly on the coordinative processes of the CNS (Meinel and Schnabel 1987). In common usage flexibility is often equated with stretchability, elasticity, suppleness, mobility etc. But as a scientific term flexibility means much more than what is conveyed by any of these terms. Flexibility can be defined as the ability to execute movements with greater amplitude or range.

Stretchability and elasticity are the special qualities of the muscles and ligaments by which these can be stretched and can regain their normal length without any adverse effect on the concerned tissue. Suppleness denotes the ability of a muscle to remain in a state of low tension there by allowing for smooth and easy movements of the limbs. Mobility pertains to the degree of movement possible in different planes at a joint. Stretchability, elasticity, mobility and suppleness, therefore, are a part and parcel of flexibility as these represent different capacities which enable the person to execute movements with greater amplitude.

Flexibility is measured by determining the range of movement possible at a joint. This has given rise to the notion that flexibility is joint specific. But in actual sports movements the range of movement is the product of range of movements possible at more than one joint. For a greater amplitude, therefore, some degree of co-ordination of different joint movements is a necessary prerequisite. In all sports movements, however, a maximum range of movement at all joints is not required. The normal amplitude required is less than the maximum possible. But a higher level of flexibility enables to achieve the required movement amplitude easily without much muscle tension etc.

Importance of Flexibility

Flexibility has important inter-relationship with other performance factors. It, therefore, determines the other factors to a lesser or greater extent. The importance of flexibility is explained briefly as follows:-

1) Flexibility is a necessary prerequisite for maximal development of movement force and speed. Greater range of movement enables the muscles to develop more force and speed.

2) Flexibility allows movements with minimum of muscle tension and internal resistance. It, therefore, has a energy saving effect. Good flexibility, therefore, helps in achieving higher movement economy.

3) The motor learning requires adequate level of flexibility of the concerned joints. For example learning of back stroke in swimming is impossible without good shoulder flexibility. Inadequate flexibility always leads to errors in movement execution and in order to remove these errors the flexibility has to be improved. Because of its effect on technique, flexibility also assumes importance for tactical skills.

4) Flexibility is indispensable for prevention of injuries. Elasticity, stretchability and suppleness of muscles and ligaments helps in absorbing the shocks and external forces tending to cause an injury. But it must be pointed out here that flexibility helps to prevent injuries only if it is optimum. If the joints are overflexible then the chances of injury increase. In other words the stability of a joint is maximum when its flexibility is optimum.

Types of Flexibility

Flexibility is of two types as described below:-

(a) Passive Flexibility

The ability to do movements with greater amplitude with external help is called passive flexibility e.g., stretching exercise with the help of a partner. The passive flexibility is always more than active flexibility and is largely determined by the joint structure and stretchability of the muscles and ligaments. Passive flexibility is the basis of active flexibility.

(b) Active Flexibility

The ability to do movement with greater amplitude without external help is called active flexibility e.g., stretching a joint by a sportsman himself without any external help. Active flexibility is always less than the passive flexibility and a large difference between the two indicates lack of muscle strength or co-ordination or both. Active flexibility is also of two types, static and dynamic. Static flexibility is required for movements done while the sportsman is standing, sitting or lying. Dynamic flexibility is required for executing movements with greater amplitude when the sportman is moving. The dynamic flexibility is always less than static flexibility and is heavily dependent on the motor co-ordination.

In addition to the above mentioned types of flexibility the terms general and special flexibility are also commonly used. The term general flexibility is used to denote the level of flexibility of all the important joints of the body e.g., shoulder, trunk and hip. It is not used in reference to any particular sport or activity. Special flexibility, however, should be understood to be the ability to do specific movement or movements of a sport with greater amplitude.

Factors Determining Flexibility

The amplitude with which a movement can be done depends on several factors which are anatomical, physical and co-ordinative in nature. In addition, there are several factors which can influence flexibility to a considerable extent. The factors determining flexibility are:-

1) Anatomical structure of the joint

A joint consists of two or more bone ends joined together by ligaments. The bone ends are in physical contact with each other. The manner in which the bone ends are joined basically decides the type and extent of movements possible at the joint. Ball and socket type joints e.g., shoulder and hip allow for greater mobility at these joints. On the other hand in a hinge joint e.g., knee and elbow only flexion and extension is possible. The anatomical structure of a joint is genetically determined and there are very less individual differences. It is practically untrainable during adulthood. But perhaps during childhood the anatomical structure of a joint can be affected by long term training to some extent.

2) Ligaments of the joint

In a joint the bone ends are joined together by ligaments which are thick bands of connective tissue. The ligaments allow the movement to take place at a joint while keeping the bone ends together. The length and arrangement of ligaments as well their elasticity primarily determine in which direction the movement can take place and to what extent. The ligaments, being connective tissues, cannot be stretched like muscles but these have some degree of elasticity. By long term training the thickness, strength and elasticity of the ligaments can be increased to some extent. But the length of the ligaments cannot be changed by training.

The ligaments basically ensure stability of a joint. If the length of the ligaments increases due to mechanical force (e.g., injury etc.), the ligaments remain in their stretched state thereby markedly lowering the stability of the joint. Such a thing happens in case of shoulder joint quite frequently and the shoulder joint thus gets easily dislocated. Surgical operation is the only remedy for lengthened ligaments.

3) Stretchability of Muscles

The strechability of the muscles is the most common factor limiting the range of movements. In all movements at a joint, the muscles must contract to execute the movement. To make the movement possible the antagonist muscles must be stretched otherwise the movement cannot be executed with the required amplitude. The range of forward bending at the trunk, with straight knees, is very frequently limited by the inability of the hamstring muscles to stretch. The muscles if not regularly stretched tend to get shorter, there by restricting the range of movement possible at a joint. The stretchability of the muscles is trainable to a considerable extent. By proper training over a period of 4-6 weeks the stretchability of the muscles can be increased to a significant extent.

4) Co-ordination

The co-ordinative processes determine flexibility, especially dynamic flexibility, to a high extent. For optimum range of movement the contraction of agonists and synergic muscles and the stretching of antagonists has to be effectively controlled and regulated by the CNS. These co-ordinative processes assume still more importance when the movement is to be done in a dynamic state of motion e.g., leg split over the hurdle during a hurdle race. In these cases the optimum range of movement has to be adequately integrated into the total co-ordination required for the motor action. The suppleness, stretchability and elasticity, through appropriate reflexes (e.g. stretch reflex), are always controlled and regulated by the CNS.

5) Strength

In order to achieve a certain movement amplitude the antagonist muscles must have a minimum level of strength required. In several gymnastic exercises as well as in sprint running the legs or knees cannot be lifted to the required height or angle if the abdominal and ilio-psoas muscles are weak. Strength obviously is highly trainable.

There are several factors which markedly influence flexibility and account for significant changes in flexibility during a day. Flexibility, therefore, is a very 'sensitive' motor ability. Some of the important factors which influence flexibility are: day temperature, muscle temperature, time of the day, emotions, fatigue, massage, warm up etc. Harre (1986) illustrates the influence of some of these factors on flexibility in the table that follows:-

Table - 23

The change in flexibility (in mm) due to different conditions (Harre 1986).

	After a night's sleep		10 min. naked stay outside (10°C)	10 min. stay in bath tub (40°C)	After a warm up of 20 min.	After tiresome training
	Morning	Noon				
Time	8.00	12.00	12.00	12.00	12.00	12.00
Result	-15	+35	-36	+78	+89	-35

Flexibility is to a significant extent age dependent. Children are more flexible than the adults. With the increase in age the flexibiltiy also decreases. Women are normally more flexible than men. This is perhaps due to sex differences in joint structure and also due to lower muscle mass thus reducing the role of muscle stretchability.

Improvement of Flexibility

For the improvement of flexibility, stretching exercises are used. These exercises can be done according to the following three methods:-

I. Ballistic method

This is perhaps the oldest method of doing stretching exercises. In this method a joint is stretched rhythmically to its maximum range. The stretching movement is done with a swing hence the name ballistic method. In the recent years the effectiveness of this method has been repeatedly doubted because 'swing' movement leads to stretch reflex in the antagonist muscles, thereby hindering the optimum stretch of these muscles. Moreover, in this method there is a higher risk of injury because of high chances of over stretching the muscle. When using this method the muscles remain in a state of optimum stretch for a fraction of a second and as a result very large number of repetitions are necessary to ensure optimum stimulus duration for improving flexibility. But in spite of all these limitations the ballistic method is more specific to the nature of sports movements and, therefore is suitable for the development of dynamic flexibility. It is advisable to use this method after the passive and static flaxibility has been improved to the desirable level by the other methods.

II. Slow Stretch and Hold Method

In this method the joint is slowly stretched to the maximum limit and is held there for a few seconds before returning to the original position. For best effect the joint must be held in a state of maximum stretch from 3-8 seconds. Longer durations do not increase the effects.

Because of the gradual stretching of the joint and muscles this method avoids the stretch reflex. To begin with, this method should be used in a modified manner. The joint should be stretched to the maximum limit slowly and then it should be brought back to the original position without any phase of holding.

This method has been found to be very effective for improving passive flexibility which forms the basis of active flexibility. For better effect the help of a partner should be taken in this method.

III. Post iso-Metric Stretch

In the past few years a new method of doing stretching exercises has evolved. It is called post iso-metric stretch and is based on the principle of proprio-ceptive neuro-muscular facilitation. According to this principle, if a muscle is contracted maximally for a few seconds then after the contraction it remains for a few seconds in a state in which it gives very low resistance to any stretch stimulus. (Dietrich et al 1985, Hebbelinck 1988).

In this method a muscle is first contracted iso-metrically for 6-7 sec. The iso-metric contraction should be maximal. After this the muscle is gradually stretched to its maximum limit and is held in this position for 8-10 sec. This procedure is to be repeated 4-8 times for each muscle group.

Additional Informations for Flexibility Training

1. Flexibility exercises must be judiciously combined with strength exercises in order to prevent decrease of muscle strength. It is best to use exercises which involve stretching and strengthening at the same time e.g., dips on the parallel bar. Post iso-metric exercises ensure improvement of flexibility along with the maintenance of strength of the muscle group being stretched.

2. The best age for the development of flexibility is before puberty. Therefore, additional stress on flexibility should be laid in this age period.

3. Flexibility once improved tends to deteriorate, especially during adolescence, if stretching exercises are not continued.

4. For good effect each muscle group must be stretched several times. Several experts have recommended at least 10-15 repetitions for each muscle group. Number of repetitions is more in ballistic method.

5. Flexibility training should aim at optimum flexibility and not maximum flexibility. Too much flexibility means less joint stability and hence higher chances of injury.

6. Stretching excercises should be done when the sportsman is fresh. Fatigue negatively affects the stretchability of the muscles. It is ideal to do stretching excercises immediately after the warm up.

7. A proper and thorough warm up is essential for stretching excercises. On the one hand it increases the muscle stretchability and on the other hand it reduces the chances of muscle injury.

8. Flexibility excercises can be done daily or even twice a day for faster improvement of flexibility. In such cases sportsman should integrate stretching exercises in his daily routine and should do them regularly and independently.

9. A stretching excercise should be accompanied by conscious effort to relax the antagonist muscles.

10. Flexibility should be improved systematically. To start with passive stretching exercises should be used gradually to be replaced by active and dynamic flexibility excercises. The exercises should be rich in variation, there by enabling the sportsman to do the movement with greater amplitude under different conditions.

11. Stretching excercises are also good for acceleration of recovery of muscle. Static stretching excercise of the loaded and tired muscles help in recovery as well as in avoiding muscle soreness and stiffness the following day. Stretching excercises for this purpose, however, should not replace cool down excercises but should be done at the end of the cool down.