Causes of muscle weakness and its prevention, general principles of muscle strengthening

Introduction

Active movement of skeletal muscle is brought about by the contraction of voluntary muscle. This muscle tissue has contractile properties which are activated by nerve impulse, to supply the effort required to move or stabilize the body lever. If resistance is applied to a muscle as its contract, the muscle will adapt, and become stronger over time. Adaptive changes can occur in muscle through the use of therapeutic exercise if the metabolic capabilities of the muscle are progressively overloaded. Muscles which are contractile tissue become stronger as a result of hypertrophy of muscle fibers and as increase in the recruitment of motor units in the muscle. The cardiovascular responds of the muscle improves so thereby increasing muscle endurance and power.

The therapeutic use of resistance is an exercise program, whether applied manually or mechanically, it is an integral part of a patient's plan of care when the ultimate goal is to improve strength, endurance and overall physical function.

All of us at some point in our life have experienced reduced power and tiredness bordering or fatigue. What causes this? This is a common complaint called muscle weakness. As the name suggests, it is the reduced strength in one or more muscles. Muscle weakness can be mild or severe, temporary or permanent, reversible or irreversible.

Causes of muscle weakness

The causes of muscle weakness may be because of four reasons.

I. Metabolic diseases or disorders
II. Brain and nerve diseases
III. Muscle diseases
IV. Other diseases or conditions

I. Metabolic diseases or disorders

1. Addison's disease: It is a disorder that occurs when the adrenal glands located at the top of the kidneys do not produce enough hormones.

2. Hyperparathyroidism: When the parathyroid glands produce too much parathyroid hormone (PTH), the disorder is termed hyperparathyroidism

3. Thyrotoxicosis: It is a common disorder in women caused by sudden worsening of hyperthyroidism (overactive thyroid glands) symptoms occurring with infection or stress.

4. Low sodium or potassium levels in the body can also cause muscle weakness.

II. Brain and nerve diseases

1. Cerebral palsy: Cerebral palsy is a brain and nervous system functioning disorder affecting movement, learning, hearing, seeing and thinking.

2. Guillain-Barre syndrome: GBS is an autoimmune disorder in which the body's immune system attacks a part of the nervous system, especially the nerve covering called myelin sheath.

3. Bells' palsy: This is a disorder which affects the nerve which controls movement of muscles in the face. Damage to this nerve causes muscle weakness or paralysis in the face.

4. Amyotrophic lateral sclerosis (ALS): Also called Lou Gehrig's disease, ALS affects the nerve cells in the brain and spinal cord that control voluntary muscle movement.

5. Multiple sclerosis: MS is a chronic progressive disorder in which the body's immune system eats away at the myelin sheath (nerve cover)

6. Stroke: A stroke is a condition in which the blood flow to the brain is interrupted by a clot or because of a ruptured blood vessel.

7. McArdle' disease: People born with this type of metabolic muscle disorder are unable to produce an enzyme called muscle phosphorylase that helps produce the energy required by the skeletal muscles for exercise.

8. Prolapsed intervertebral disc: Sometimes, pinched nerve due to slipped disk in the spine causes muscle weakness.

III. Muscle diseases

1. **Myositis**: Myositis or muscle inflammation involve a group of muscle diseases such as – **dermatomyositis** which is a muscle inflammation with patchy, dusky and red or purple skin rashes,
polymyositis, more common in women than in men, in which muscle weakness happens over days, weeks or months and begins in the neck, hip, back, and shoulder muscles.
Inclusion-body myositis, mostly occurring in men, in which the muscle weakness and shrinking is first observed in the thigh muscles, forearm muscles and muscles below the knee,
juvenile myositis occurring in children under the age of 18 and skin rash is the first symptom.

2. **Muscular dystrophy**: It is a group of inherited disorders that involve muscle weakness that gets worse over time with subsequent muscle loss. Common muscle dystrophies include –
Becker muscular dystrophy is a slowly progressing condition that affects only male and causes weakness and wastage of muscles;

Duchenne muscular dystrophy is a serious quickly progressive neuromuscular condition caused by a lack of a protein called dystrophin.
Myotonic dystrophy is a condition that involves weakness and slowly progressive wasting of voluntary muscles in the face, neck, and lower arms and legs.

IV. Other diseases/conditions
1. Poisoning
2. Myasthenia gravis
3. Anaemia
4. Post polio syndrome

Prevention of muscle weakness and muscle wasting
In flaccid paralysis
Muscles deprived of their motor nerve supply are limp, hypotonic and unable to contract. Rapid wasting takes place and cannot be prevented, although it is thought that it can be arrested by improving the blood supply to the area by stimulating of the muscle fibers by electrical means.

Principle of treatment during flaccid paralysis
1. The affected muscles must be protected from prolonged overstretching by adequate support and splintage.

2. The circulation to the area must be maintained to ensure adequate nutrition to the paralyzed muscle by the active exercise for other normal muscles in the area.

3. The range of movement in joint immobilized by the paralysis and the extensibility of the affected muscle must be maintained by passive movements.

4. Remembrance of the pattern of movement must be stimulated and kept alive by passive movements while active movement is impossible.

5. The strength and use of normal muscles in the area must be maintained by resisted exercise.

In spastic paralysis
In spastic paralysis muscles received a motor nerve supply only by means of a spinal reflex, since they are cut off from the higher centers by lesion affecting the upper neuron; those muscles are tense, hypertonic and incapable of voluntary contraction or relaxation. This condition is known as spastic paralysis and wasting is not marked.
When a limb or segment of body is locked in spasm, circulation is impeded and muscle and joint contracture may develop over a period of time. The aim of treatment is to initiate movement to maintain normal joint range and muscle extensibility and at the same time improve the circulation. Controlled sustained passive stretching also inhibits spasm sufficiently to permit movement.

In primary lesion of the muscle tissue
In this case loss of power cannot be arrested, although a temporary improvement often follows light exercise in case which have not previously received treatment.

In disuse atrophy
Provided there is no constitutional disease e.g Rheumatoid disease, muscle atrophy from disuse can be prevented or controlled by strong and frequent contraction against resistance as wasting occurs because an insufficient demand is made to elicit a strong enough contraction.

Measures used to obtain initiation of contraction
1. Warmth: The area affected must be warm, as moderate warmth improves the quality of contraction. Any method design to improve the circulation in the area is effective; active exercise of unaffected muscle against strong resistance is the method of choice.
2. Stabilization: Stabilize the bones of origin of the affected muscles and joints distal to those over which these muscles work improves their efficiency. Whenever possible, stabilization should be achieved by isometric contraction of strong synergic muscles working.
3. Grip or manual contact: The physiotherapist's hand gives pressure only in the direction of the movement, to direct the patient's effort and give sensory stimulation.
4. Stretch: Stimulation of the muscle spindle elicits reflex contraction of that muscle provided the reflex arc is contact. Sharp but controlled stretching of the affected muscle at the limit of its extended range is followed immediately by the patient's maximum contraction.

5. Irradiation
a. The use of resistance to functional movements of the opposite limbs which normally produces fixators action on the other side can assist initiation of contraction in the affected muscle.

b. Use of resistance to strong groups which normally work with the affected muscle also encourages contraction of that muscle.

Goal and indication of resistance exercise
i. Increase strength.
ii. Increase muscular endurance.
iii. Increase power.

General principle of muscle strengthening
Once the power of contraction has been regained, the muscles should be strengthened progressively until maximum function is obtained. Passive movements support and artificial methods of assisting the circulation are discontinued gradually and are replaced by active exercise. The general principle of muscle strengthening should be

1. The affected muscles must be strengthened progressively by resisted exercises, which are specific for the group to which the muscles belong

a. Range: The range of movement is increased.

b. Type of muscle work: concentric, eccentric and static muscle work is elicited.

c. Resistance: the Resistance is increased by,
    i. increasing the poundage of the resistance
    ii. Increasing the leverage of the resistance

d. Speed: Increase or decrease in the speed of movement is a progression for concentric work. Decrease in speed is a progression for eccentric work. Lengthening of contraction period is a progression for static holding.

e. Duration: Increase in the number of time of an exercise performed or decrease in the rest period between each series of exercise, or a combination of both according to circumstance, makes more work for the muscle.

2. Full range of the affected muscle as a member of the team of muscle which work to produce skilled and co-ordinated movement, must be restored by free activities, natural and skilled movement.

Types of exercise used to strengthen muscle and restore function

All active exercise maintains or increase muscle strength providing intra-muscular tension is increased sufficiently by demand of the resisting force. Weak muscles are provided with work suitable to their capacity by the use of assisted-resisted, free or resisted exercise while objective, recreational or occupational activities ensure their return to functional use. In general, strengthening exercises are slow and precise. The techniques of strengthening exercise are

a. Assisted-Resisted exercise
b. Free exercise
c. Resisted exercise
d. Activities
e. Assessment of progression

a. Assisted-Resisted exercise: These are rarely used to strengthen muscle except in case of marked weakness when strength is insufficient to complete the range of movement. Assistance is provided in the weak range and resistance is given in the strong range of the muscle.

b. Free Exercise: Free exercises are valuable as they can be practiced at regular and frequent interval at home. Careful selection of the starting position and accurate teaching ensure the use of the muscle and grade the exercise to match their capacity for work.

c. Resisted exercise: Resisted exercise is any form of active exercise in which a dynamic or static muscular contraction is resisted by an outside force. The external force may be applied manually or mechanically

i. Manual resistance exercise: it is a type of active exercise in which the resistance is provided by the therapist or other health professional. This technique is useful in early stage of an exercise program when the muscle to be strengthened is weak and can overcome only mild to moderate resistance.

ii. Mechanical resistance exercise: it is a form of active exercise in which resistance is applied through the use of equipment or mechanical apparatus. The amount of resistance can be measured quantitatively and progress over time. It is often used in specific resistance exercise regiments.

d. Activities: These are essential to ensure integrated action of muscle group in the production of movement. They also restore confidence and general health.

e. Assessment of progression: Re-assessment of the patient's abilities is made at frequent intervals to guide progression of activities and estimate progress.

Precaution for strengthening exercise.

1. Valsalva maneuver: It is an expiratory effort against closed glottis, and must be avoided during resistance exercise.
2. Patient with a history of cardiovascular problem.
3. Patient with a history of abdominal surgery.
4. Fatigue

a. Local muscle fatigue: diminished response of a muscle to a repetitive stimulus.
b. General muscle fatigue: diminish response of a person during prolonged physical activities such as walking or jogging.

5. overwork/overtraining
6. Substitute motion: weak muscle work can be substitute by normal acting muscle.
7. Osteoporosis
8. Exercise induced muscle soreness

Conclusion

Many factors, such as disease, disuse and immobilization may result in muscle weakness. The therapeutic use of resistance in an exercise program, whether applied mechanically or manually, is an integral part of patient's plan of care when the ultimate goal is to improve strength, endurance and overall physical function.