TESTS AND MEASUREMENTS

Lec. 2:

Principles and methods

Rehab S. Mamoon
Lecturer of Physical Therapy, SVU

Assessing Muscle Length

- Muscle length refers to the ability of a muscle crossing a joint or joints to lengthen, thus allowing the joint or joints to move through their full available range of motion.
- A muscle's ability to lengthen is essential for functional activities, so rehabilitation professionals need to consider muscle length when assessing and treating patients.

Muscle Length Assessment

- The muscle length assessment helps determine whether a muscle's length is normal, decreased or increased. This assessment can help identify if changes in muscle extensibility are contributing to a movement impairment and/or symptoms or if other structures are involved.

Muscle Length Assessment

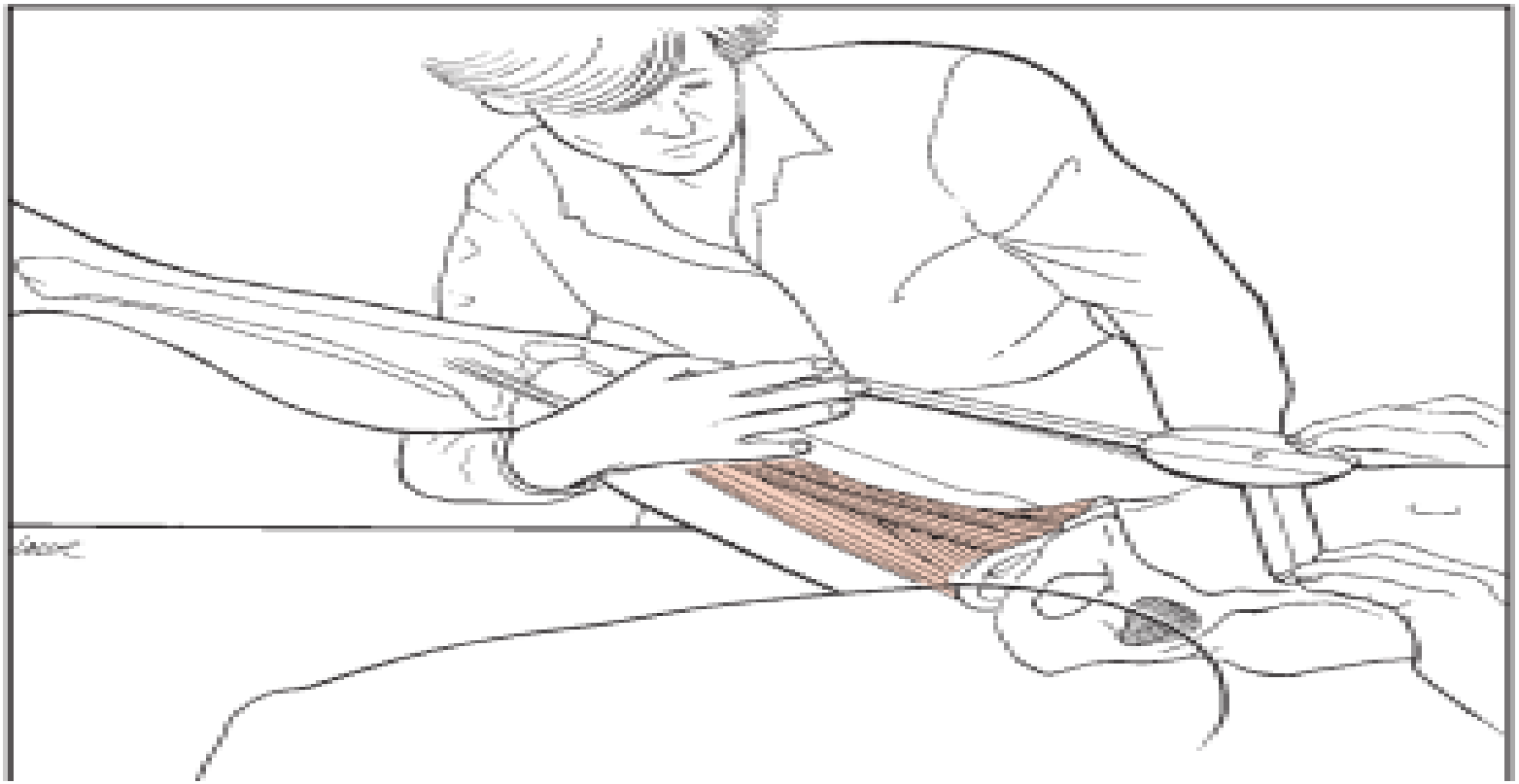
- To test muscle length, we must position the muscle so that the distance between its origin and insertion increases - i.e. we lengthen the muscle in the direction opposite to its action.
- For example, to measure the length of the hip flexors, we position the hip in extension.

- In the direct measurement method, the distance between adjacent joint segments is measured. When using this method, we must consider that muscles are characterized by the number of joints they cross, i.e., one-joint, two-joint, and multi-joint muscles.

One Joint Muscles

- One-joint muscles cross just one joint. They typically allow full passive range of motion at the joint they cross. If a one-joint muscle is short and limits the range of motion, you will notice a firm end feel caused by muscle tension.
- To determine the length of a one-joint muscle, we measure the passive range of motion of the joint that it crosses in the direction opposite to its action.

- ***Example***: To measure the length of adductor longus, brevis and magnus:
- Position the hip joint so that these muscles are in a lengthened position - i.e. hip abduction
- Measure the degree of passive hip abduction achieved



Two-Joint Muscles

- Muscles that cross two or more joints typically do not allow full range of motion across all the joints they cross. This is known as passive insufficiency.
- "Passive insufficiency occurs when a multi-joint muscle is lengthened to its fullest extent at both joints, thereby preventing the full range of motion of each joint it crosses."

Two-Joint Muscles

- To assess and measure the length of a two-joint muscle, we must:
- Position one of the joints so that the muscle is in a lengthened position
- Move the second joint passively until the muscle is on full stretch and prevents further motion at the joint
- Measure the final position of the second joint to determine muscle length

- ***Example #1*:** Measuring biceps brachii length vs elbow extension range of motion.
- Biceps brachii crosses the shoulder and the elbow. It flexes and supinates the elbow and is a weak shoulder flexor. To test the length of biceps brachii:
- Position the patient in a supine
- Place the arm in shoulder extension, elbow flexion and supination
- Passively extend the elbow and measure the elbow extension range to determine the length of biceps brachii

- To measure extension of the elbow *joint*, position the shoulder joint in neutral to prevent passive insufficiency of biceps brachii from affecting your results & compare.

- Example 2: To assess and measure the length of the two joint triceps muscle, place the shoulder in full elevation to stretch the triceps across the shoulder joint

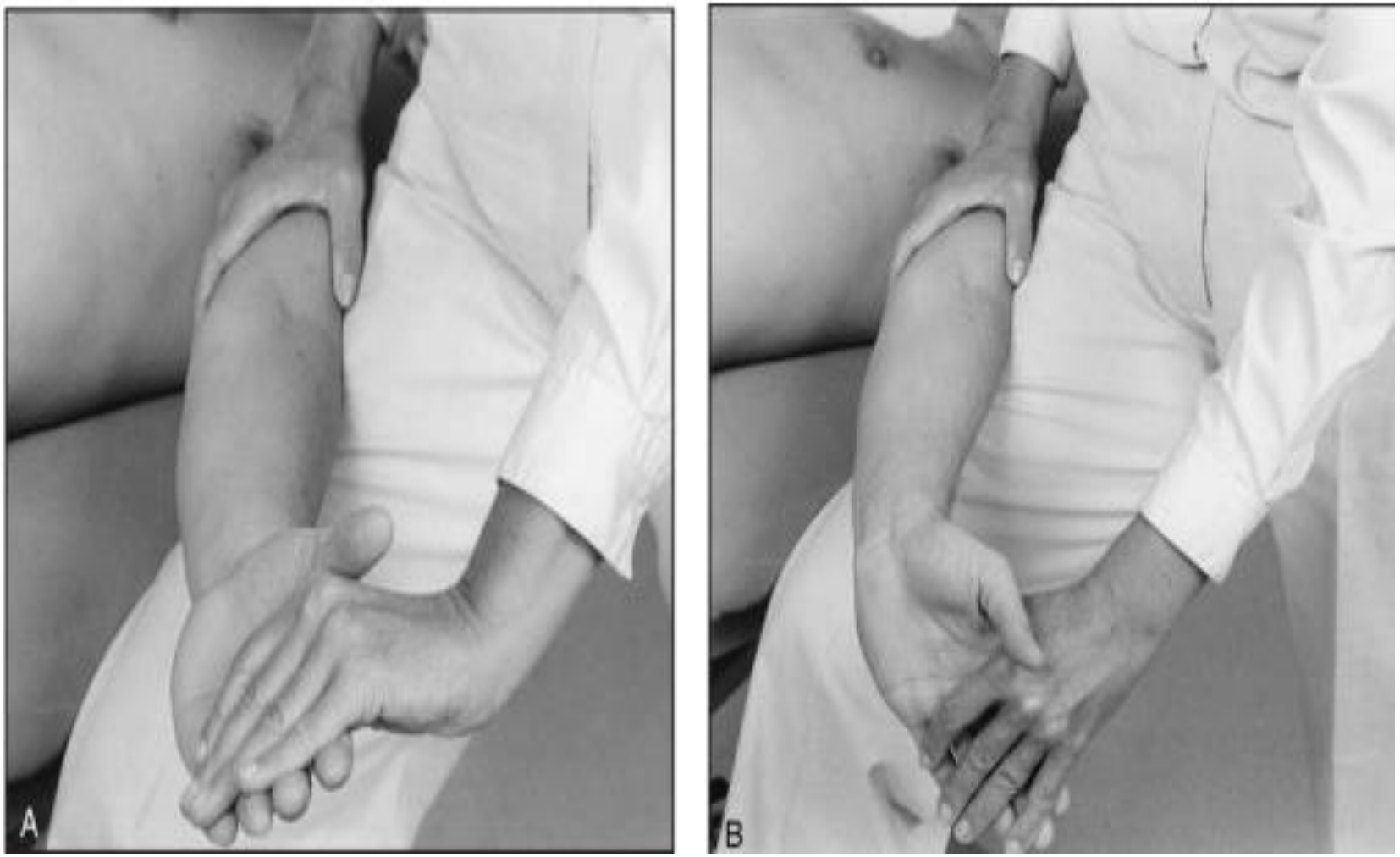
- ***Example #3*:** Measuring rectus femoris length vs knee flexion range of motion.
- Rectus femoris crosses the hip and knee. It flexes the hip and extends the knee.
- To test the length of rectus femoris:
- Position the patient in prone
- Passively flex the knee and measure the angle of knee flexion to determine the length of rectus femoris
- NB: If the hip flexes during the movement, we know there are length limitations in rectus femoris - this is also known as Ely's Test

- To measure flexion of the knee *joint*, position the patient in supine and assess knee flexion range (actively and passively). In this position, the hip can flex during the movement, which prevents passive insufficiency of rectus femoris from affecting results.

Multi-joint Muscles

- To measure the length of a multi-joint muscle, all but one of the joints are positioned with the tested muscle in a lengthened position.
- We then move the remaining joint crossed by the muscle passively until the muscle is on full stretch and prevents further motion at the joint.
- We assess and measure the final position of this joint to determine muscle length.

- ***Example***:
- To assess and measure the length of the multi-joint finger flexor muscles, place the elbow and fingers in full extension to stretch the muscles across these joints .
- Extend the wrist to place the flexors on full stretch .
- The end feel will be firm if the finger flexors limit wrist extension PROM. The position of wrist extension PROM can be measured using a universal goniometer to indirectly represent the muscle length of the finger flexors.


A
B

Manual Assessment of Muscle Strength

- Manual muscle testing is a procedure for the evaluation of the function and strength of individual muscles and muscle groups based on effective performance of a movement in relation to the forces of gravity and manual resistance.

Muscle Testing Terminology

- **Muscle Strength**
  Strength is the maximal amount of tension or force that a muscle or muscle group can voluntarily exert in one maximal effort. Use of the term muscle strength in the clinical setting actually represents torque.

Muscle Testing Terminology

- **Torque (F X D):-**

Torque is the tendency of a force (i.e., muscle tension, a therapist's pull or push, or gravity) to turn a lever (i.e., a limb or limb segment) around an axis of rotation (i.e., the joint axis of rotation) in either a clockwise (cw) or counterclockwise (ccw) direction.

Types of Muscle Contraction

- **Isometric (Static) Contraction.**

An isometric contraction occurs when tension is developed in the muscle
but no movement occurs, the origin and insertion of the muscle do not change position, and the muscle length does not change.

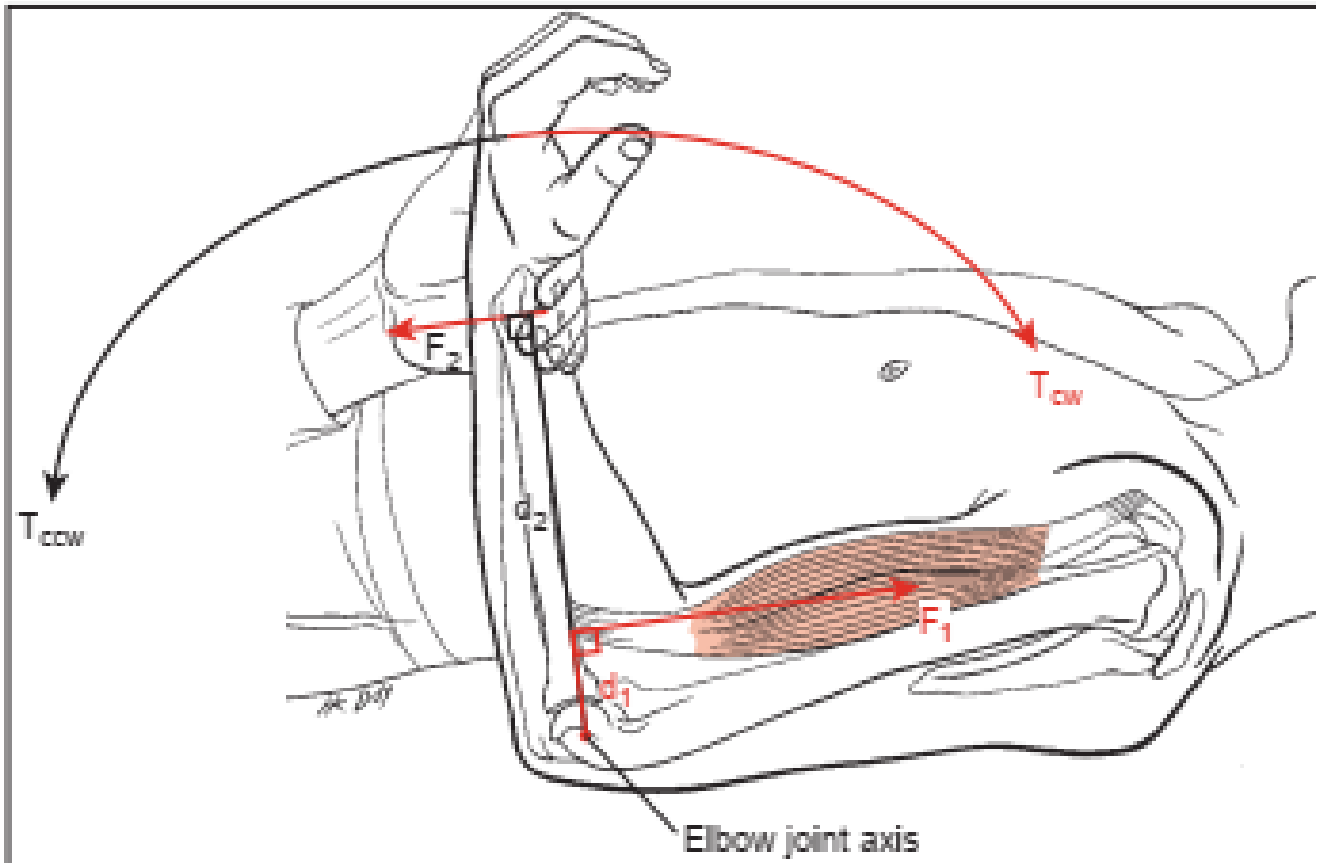
Tension generated in the muscle = External force

- **Concentric Contraction.** Tension is developed in the muscle and the origin, and insertion of the muscle move closer together; the muscle shortens.

  Tension generated in the muscle > External force

- **Eccentric Contraction.** Tension is developed in the muscle and the origin and insertion of the muscle move farther apart; the muscle lengthens.

  Tension generated in the muscle < External force


T_{ccw}
F_2
d_2
T_{cw}
F_1
d_1
Elbow joint axis

- **Isotonic Contraction.**

The muscle develops constant tension against a load or resistance.

- **Isokinetic Contraction.** The muscle contracts at a constant rate of movement or velocity.

- **Muscle Endurance**

  Endurance is the ability of a muscle or a muscle group to perform repeated contractions, against a resistance, or maintain an isometric contraction for a period of time.[66]

  Muscle Fatigue[16]

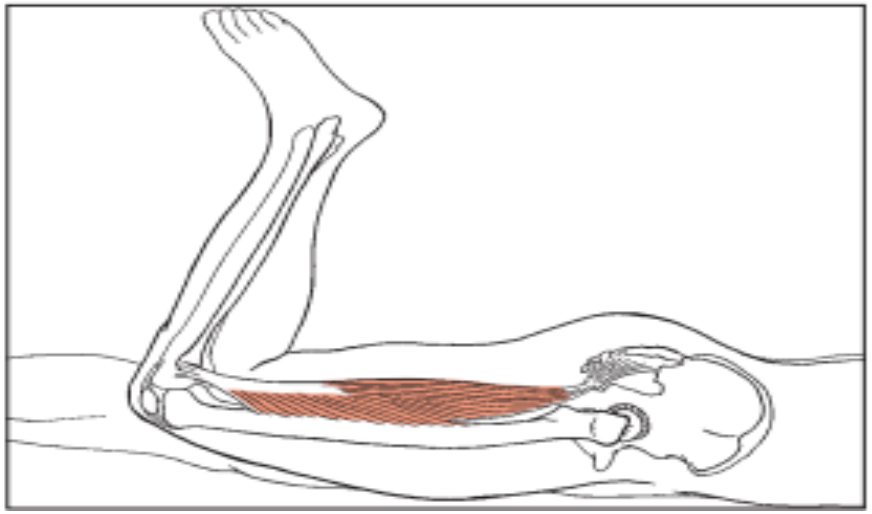
  Fatigue is a diminished response of the muscle to generate force that may be due to a lack of energy stores or oxygen, a buildup of lactic acid, protective inhibitory influences from the central nervous system, or a decrease in conduction impulses at the myoneural junction.

- **Overwork**[15]

  Overwork is a phenomenon that causes a temporary or permanent loss of strength in already weakened muscle due to excessively vigorous activity or exercise relative to the patient’s condition.

- **Active Insufficiency**

The active insufficiency of a muscle that crosses two or more joints occurs when the muscle produces simultaneous movement at all of the joints it crosses and reaches such a shortened position that it no longer has the ability to develop effective tension.

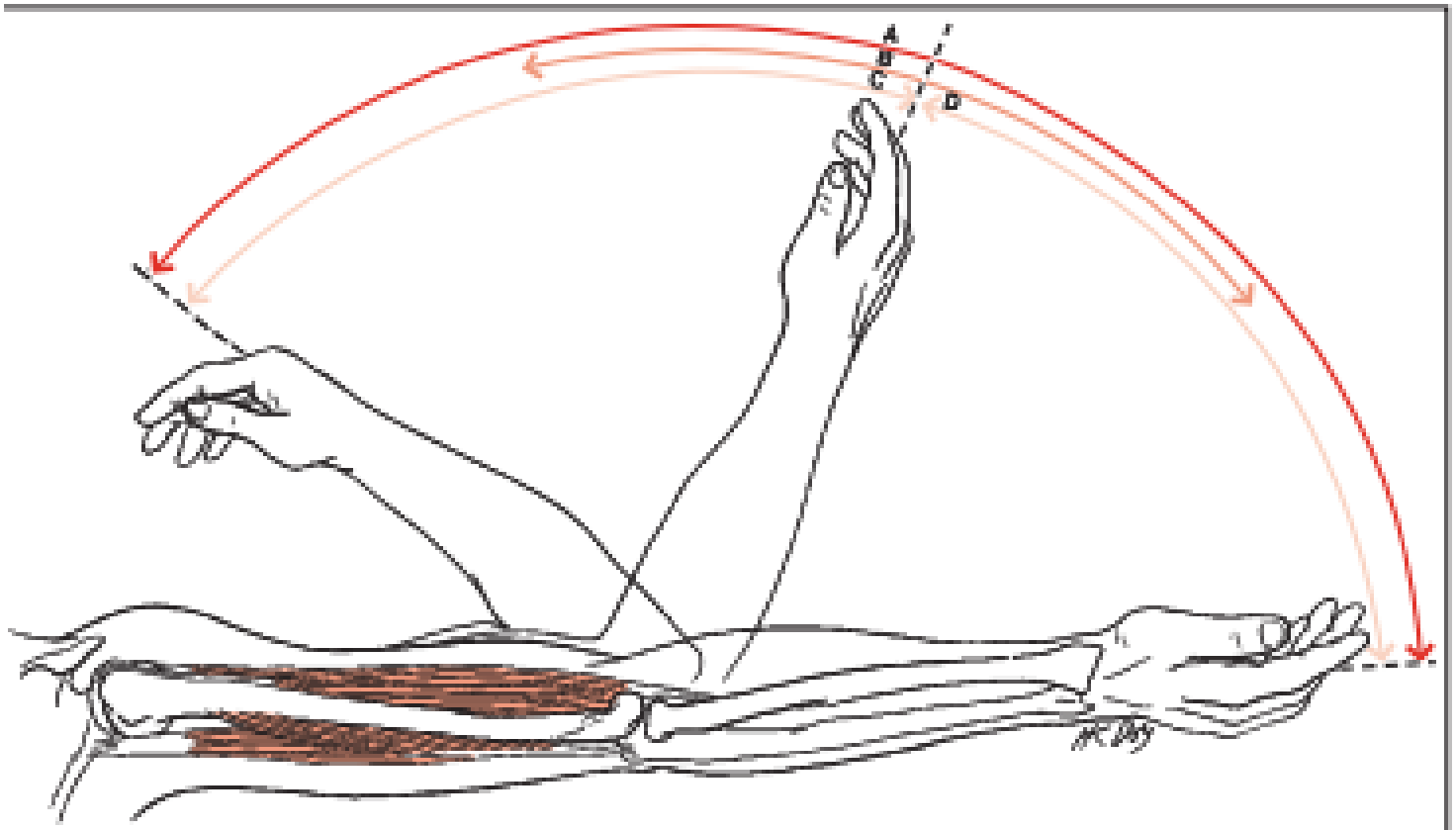


Ranges of Muscle Work

The **full range** in which a muscle works refers to the muscle changing from a position of full stretch and contracting to a position of maximal shortening.

- The full range can be more precisely described if it is divided into parts: outer, inner, and middle ranges.

- **Outer range** is from a position where the muscle is on full stretch to a position halfway through the full range.
- **Inner range** is from a position halfway through the full range to a position where the muscle is fully shortened.
- **Middle range** is the portion of the full range between the midpoint of the outer range and the midpoint of the inner range.



A. Full range: Biceps and triceps
B. Middle range: Biceps and triceps
C. Inner range: Biceps
   Outer range: Triceps
D. Inner range: Triceps
   Outer range: Biceps

Functional Classification of Muscle

- **Prime Mover or Agonist.** This is a muscle or muscle group that makes the major contribution to movement at the joint.
- **Antagonist.** An antagonist is a muscle or muscle group that has an opposite action to the prime mover or agonist. The antagonist either relaxes to allow the agonist to move the part through a ROM, or may contract concurrently to control or slow the movement.

- **Synergist.** A synergist is a muscle that contracts and works along with the agonist to produce the desired movement. Synergists function in different ways to
  assist the prime mover to produce the movement.
  Three types of synergists:
-

- ***Neutralizing or Counteracting Synergists.***

These are muscles that contract to prevent unwanted movements produced by the prime mover. For example, when the long finger flexors contract to produce finger flexion, the wrist extensors contract to prevent wrist flexion from occurring.

- ***Conjoint Synergists.***

Conjoint synergists are two or more muscles that work together to produce the desired movement. The muscles contracting alone would be unable to produce the movement. For example, wrist extension is produced by contraction of extensor carpi radialis longus and brevis and extensor carpi ulnaris. If only the extensor carpi radialis longus and brevis contract, the wrist extends and radially deviates. If only the extensor carpi ulnaris contracts, the wrist extends and ulnar deviates. When the muscles contract as a group, the radial and ulnar deviation actions of the muscles cancel out and the common action of wrist extension results.

- ***Stabilizing or Fixating Synergists.***

These muscles prevent movement or control the movement at joints proximal to the moving joint to provide a fixed or stable base from which the distal moving segment can effectively work.

For example, if the elbow flexors contract to lift an object off a table anterior to the body, the muscles of the scapula and glenohumeral joint must contract to either allow slow controlled movement or no movement to occur at the scapula and glenohumeral joint, to provide the elbow flexors with a fixed origin from which to pull. If the scapular muscles do not contract, the object cannot be lifted because the elbow flexors would act to pull the shoulder girdle downward toward the table top.

Factors Affecting Strength

- Age . Muscle strength increases from birth to a maximum point between 20 and 30 years of age. Following this maximum, a decrease in strength occurs with increasing age due to deterioration in muscle mass.
- Gender. Men are generally stronger than women.
- Muscle Size. The larger the cross-sectional area of a muscle, the greater the strength of the muscle.

- Speed of Muscle Contraction. When a muscle contracts concentrically, the force of contraction decreases as the speed of contraction increases.
- Type of Muscle Contraction. The ability to develop tension in a muscle varies depending on the type of muscle contraction. More tension can be developed during an eccentric contraction than during an isometric contraction. A concentric contraction has the smallest tension capability. When assessing strength, the same type of contraction should be used on successive tests.

Contraindications:-

- 1 –inflammation.
- 2-inflammatory neuromuscular disease (e.g., Guillain-Barre, polymyositis, dermatomyositis).
- 3-severe cardiac or respiratory disease.
- 4-In the presence of pain. Pain will inhibit muscle contraction and will not give an accurate indication of muscle strength.

Precautions:-

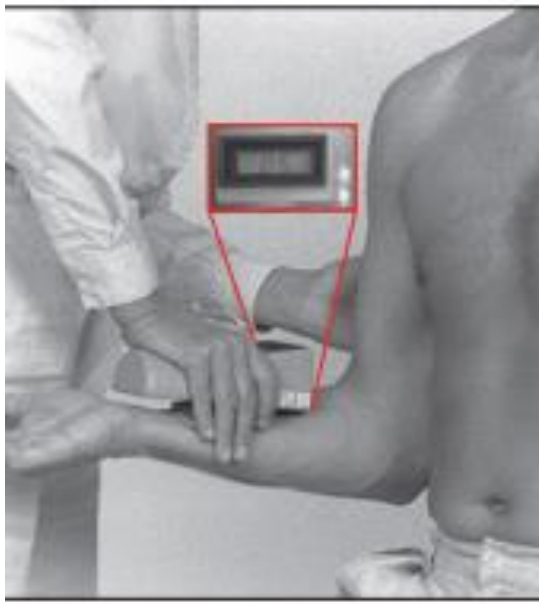
- 1-neurosurgery or recent surgery of the abdomen, intervertebral disc.
- 2- fatigue.
- 3-overwork.

Muscle strength assessment

- **Instrumentation**

hand grip dynamometer.

a pinch dynamometer.



a hand-held dynamometer (HHD

MMT Method of Assessing Muscle Strength

Conventional Method: Manual grading of muscle strength is based on three factors

1. **Evidence of contraction**:
- No palpable or observable muscle contraction (grade 0)
- A palpable or observable muscle contraction and no joint motion (grade 1)

2. **Gravity as a resistance**—ability to move the part through the full available ROM:
- Gravity eliminated (grade 2)
- Against gravity (grade 3)

3. **Amount of manual resistance**—ability to move the part through the full available ROM against gravity and against:
- Moderate manual resistance (grade 4)
- Maximal manual resistance (grade 5).

Numerals	Letters	Description
Against Gravity Tests		
5	N(normal)	The full available ROM against gravity and against maximal resistance.
4	G (good)	The full available ROM against gravity and against moderate resistance.
4 -	G -	If testing "through range"; grade n/a if testing "isometrically": Greater than one half the available ROM against gravity and against moderate resistance
3+	F+	If testing "through range": Less than one half the available ROM against gravity and against moderate resistance If testing "isometrically": The full available ROM against gravity and against minimal resistance
3	F(fair)	The full available ROM against gravity
3-	F-	Greater than one half the available ROM against gravity
2 +	P+	Less than one half the available ROM against gravity

Gravity eliminated test		
2	P(poor)	The full available ROM gravity eliminated
2 -	P -	Less than the full available ROM gravity eliminated
1	T(trace)	None of the available ROM gravity eliminated and there is a palpable or observable flicker of a muscle contraction
0	0(zero)	None of the available ROM gravity eliminated and there is no palpable or observable muscle contraction Note: When the patient cannot be positioned as required relative to gravity, or

Procedures of manual muscle test

- Explanation and Instruction

Briefly explain the manual muscle test assessment procedure to the patient.

- Assessment of Normal Muscle Strength

Initially assess and record the strength of the uninvolved limb to determine the patient's normal strength (i.e., grade 5) and to demonstrate the movement before assessing the strength of the involved side.

- **Patient Position**

➢ Position the patient to isolate the muscle or muscle group to be tested in either a gravity eliminated or against gravity position.

➢ Ensure the patient is comfortable and adequately supported.

➢ Place the muscle or muscle group being tested in full outer range.

Stabilization .

- Stabilize the site of attachment of the origin of the muscle so that the muscle has a fixed point from which to pull. When testing a two- or multi-joint muscle, stabilize or fix the segment proximal to the joint where movement occurs to test the muscle action.
- Prevent substitute movements by making use of the following methods of stabilization:
  1. The patient's body weight—use to help fix the shoulder girdle, pelvic girdle or trunk.
  Example:
  The weight of the trunk on the plinth serves to stabilize the spinal origin of the rhomboid muscles

The weight of the trunk on the plinth serves to stabilize the spinal origins of the rhomboid muscles.

- 2. The patient's normal muscles—have the patient use muscles that
  - would normally act as stabilizing or fixating synergists for the movement,

    Example:

    When strength testing the rhomboid muscles, instruct the patient to maintain an upright sitting position as the hand is moved directly off the contralateral buttock
- - are not normally used to perform the test movement,

    Example:
  - Instruct the patient to hold the edge of the plinth when the hip is flexed to assess the strength of the hip flexors

The patient contracts the trunk muscles to maintain the upright sitting position and stabilize the trunk when rhomboid muscle strength is tested.

The patient holds the edge of the plinth to stabilize the spine and pelvis when the strength of the hip flexors is tested

- The patient’s position:
  Example:
  When assessing hip abductor muscle strength in the side-lying position, instruct the patient to hold the nontest leg in maximal hip and knee flexion. In this position, the posterior tilt of the pelvis
  acts to stabilize the pelvis and lumbar spine.

The patient holds the nontest leg in maximal hip and knee flexion to stabilize the pelvis, i.e., the origin of the hip abductor muscles.

- **Substitute Movements.**

When muscles are weak or paralyzed, other muscles may take over or gravity may be used to perform the movements normally carried out by the weak muscles.

The therapist manually stabilizes the radius and ulna to assess wrist extensor muscle strength.

سبحانك اللهم وبحمدك

أشهد أن لا إله إلا أنت أستغفرك وأتوب إليك

Thank you