

Neurological: Part 4

Muscle Strength

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Overview

When pathology exists in the spinal cord and/or nerve roots, corresponding symptoms and signs will be present in the corresponding extremities according to the specific neurologic levels involved. Each level has its own specific neurological characteristics and can provide an indication of which spinal cord and nerve root level is involved.

Differentiation between spinal cord vs. nerve root pathology vs. peripheral nerve injuries is reflected in differences in the distribution of the neurologic findings of motor power, sensation, and reflex. This differentiation between spinal cords and nerve root levels involved depends on the dermatomes (sensation), myotomes (muscle) and reflexes findings. While each dermatome and myotome is enervated at a cord level and by a peripheral nerve, each has its own distinct pattern of enervation. Dermatomes are the areas of sensation on the skin supplied by a single spinal segment. The myotomes are the groups of muscles enervated by a single spinal segment. The dermatomes, myotomes and reflexes provide information as to the level of lesion involvement.

Nerves have two functions, motor and sensory. Signals are sent back and forth between the brain, spinal cord and nerves to the body's organs. The impulses which supply the muscles with information are carried by the spinal cord. Motor information travels in the spinal cord primarily by the corticospinal tract. If there is an interruption of this impulse or signal to the muscle, such as spinal cord injury, the myotome results in spastic paralysis. Whereas pressure on the nerve root may cause a decrease in muscle strength.

Equipment for a Neurological Evaluation

When performing the examination concerning the nervous system, the equipment needed include:

- Penlight
- Tongue blade
- Sterile needles
- Tuning forks, 128 Hz and 512 Hz
- Familiar objects – coins, keys, paper clip
- Cotton wisp
- Reflex Hammer
- Vials of aromatic substances – coffee, orange, peppermint extract, oil of cloves
- Vials of solutions – glucose, salt, lemon or vinegar, or quinine – with applicators
- Test tubes of hot and cold water fro temperature sensation testing
- Tape measure
- J-mar Grip Strength Hand Dynamiter

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. Manual muscle testing can be used to assess most medical conditions. However, it has limitations in the treatment of neurological disorders where there is an alteration in muscle tone if reflex activity is altered or if there is a loss of cortical control due to lesions of the central nervous system.

Muscle strength testing of the upper and lower extremities evaluates lesions affecting the motor portion of the nerve. A weakness of the muscle corresponds with a nerve root level. Factors which affect the muscle strength includes:

- Age,
- Sex,
- Type of Muscle Contraction,
- Muscle Size,
- Speed of Muscle Contraction,
- Previous Training Effect,
- Joint Position (angle of muscle pull),
- Length-Tension Relations, and
- Fatigue.

Contraindications and Precautions to Muscle Testing

Muscle strength must NOT be assessed manually if any contraindications exists. In special instances the assessment techniques must be carried out with a modified approach. The same contraindications and precautions for assessing **active or passive ROM** apply when manually assessing muscle strength.

Manual assessment of muscle strength is contraindicated where:

1. Inflammation is present in the region.
2. Pain is present. Pain will inhibit muscle contraction and will not give an accurate indication of muscle strength. Testing muscle strength in the presence of pain may cause further injury.

Manual assessment of muscle strength can be performed but extra care is needed.

Extra care must be taken when restricted movements might aggravate the condition, such as:

1. Patients with a history of or at risk of having cardiovascular problems, such as, suspected or known aneurysm, fixed-rate pacemaker, arrhythmia, angina pectoris, suspected or known thrombophlebitis, etc.
2. Patients who have experienced abdominal surgery or patients with herniation of the abdominal wall (unless the patient is carefully instructed against the Valsalva maneuver and the test does not put unsafe levels of stress on the abdominal wall).
3. In a situation where fatigue may be detrimental to or exacerbate the patient's condition. Patients with extreme debility, for example, malnutrition, malignancy, and severe chronic obstructive pulmonary disease. These patients do not have the energy to carry out strenuous testing.

Muscle Testing Terminology

Muscle Strength:

The maximal amount of tension or force that a muscle or muscle group can voluntarily exert in one maximal effort, when type of muscle contraction, limb velocity, and joint angle are specified.

Muscular Endurance:

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.

Isometric (Static) Contraction:

This is when there is tension developed in the muscles but **no movement** occurs, the origin and insertion of the muscle do not change position, and the muscle length does not change.

Isotonic Contraction:

The muscle develops **constant tension** against a load or resistance.

Concentric Contraction:

Tension is developed in the muscle when the origin and insertion of the muscle **move closer together**; the muscle **shortens**.

Eccentric Contraction:

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

Manual Assessment of Muscle Strength

After active and passive ROM have been completed, manual assessment of muscle strength is performed.

Muscles with a common action or actions may be tested as a group of muscles or they may be tested individually.

Procedure for Manual Muscle Testing

- 1. Explanation and Instruction:** Briefly explain the manual muscle test assessment procedure to the patient. The practitioner demonstrates and/or explains the movement to be performed and/or passively moves the patient's limb through the test movement.
- 2. 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. If the contralateral limb can not be used for comparison, the practitioner must rely on past experience with other like patients to judge the patient's normal strength considering the factors that affect strength, such as, the patient's age, sex, dominance and occupation.
- 3. Patient Position:** The patient is positioned to isolate the muscle or muscle group to be tested in either a gravity-eliminated or against gravity position. Ensure that the patient is comfortable and well supported. The muscle or muscle group being tested is placed in full outer range, with only slight tension being placed on the muscle. When assessing muscle

strength good control and specificity of body position chosen during testing is essential to produced valid strength estimates.

4. **Stabilization:** Stabilize the muscle's attachment site, (the origin of the muscle) so that the muscle has a fixed point from which to pull. Prevent substitutions and trick movements by making use of the following methods of stabilization:
 - A. **The patient's body weight** – used to help fix the shoulder or pelvic girdles.
 - B. **The patient's normal muscles** – (a) having the patient use muscles that are not normally used when performing the test movement, e.g. the patient holds the edge of the plinth when hip flexion is tested or (b) having the patient use the fixator muscles that would normally act as stabilizers for the movement, e.g. the scapular muscles when glenohumeral flexion is performed.
 - C. **The patient's position** – for example, when assessing hip abduction muscle strength in the side-lying position, the patient holds the non-test leg in maximal hip and knee flexion in order to tilt the pelvis posteriorly and fix the pelvis and lumbar spine.
 - D. **External forces** – (a) external pressure applied directly by the therapist and (b) devices such as belts and sandbags.
5. **Testing:** If the patient is able to move through the full ROM against gravity, the test is repeated against manual resistance to determine the grade. The practitioner uses a lumbrical grip, in which the metacarpophalangeal joints are flexed with the interphalangeal joints held in extension and the thumb either adducted or relaxed in slight extension, to apply resistance. Add resistance gradually to allow the patient to "set" the muscles. The resistance force is applied at a 90 degree angle to the limb segment.

Apply the resistance force at the distal end of the segment into which the muscle(s) being tested is (are) inserted. Allowing a joint to come between the point of application of the resistance and the muscle insertion may increase the chance of substitution.

Ensure resistance is not given distal to an unstable or weakly supported joint. Every attempt should be made to keep the length of the resistance arm (i.e. the distance between the axis of rotation of the joint and the point of application of the manual resistance) standard for each muscle test. Note: The longer the length of the resistance arm, the less the resistance force is required by the practitioner to contract the moment of torque produced by the muscle.

It has been found that if the practitioner gives an equal or greater resistance to the

limb when testing muscle A for a shorter period of time than when testing muscle B, it is possible that muscle A could be assessed as being weaker than muscle B. When applying resistance to test a muscle the practitioner mentally integrates the time taken to go through the ROM with the magnitude of the resistance force to arrive at a perception of the strength deficit and assign a grade. Because of this and the force velocity relationships, the practitioner should use the same time and the same velocity of movement to go through the ROM when performing comparable muscle tests.

Muscle Strength Grading

Note muscle strength by graded scale.

- 5 (Normal)** Complete range of motion against gravity with **full resistance**.
- 4 (Good)** Complete range of motion against gravity with **some resistance**.
- 3 (Fair)** Complete range of motion **with gravity**.
- 2 (Poor)** Complete range of motion **with gravity eliminated**.
- 1 (Trace)** Evidence of **slight contractility**. No joint motion.
- 0 (Zero)** **No evidence** of contractility.

The results are recorded by the descriptive word, Good, Trace, etc., or by numerically listing the finding over the normal. For example: The upper extremities were 5/5 bilaterally except for the **right biceps at 4/5**.

Measuring Hand and Grip Strength

A dynamometer is a device to measure hand grip and finger muscle strength. The device measures in pounds or kilograms of force. The measurement is made three times alternating between sides allowing for a rest between samples. The patient is sitting with the elbow at 90 degrees when gripping the dynamometer. The patient is instructed to make one full effort to reach maximum strength.



Cervical Spine Extrinsic Musculature with Specific Nerve Roots

Upper Extremity	
Nerve Root	Action
C5	Shoulder abduction
C6	Wrist extension
C7	Wrist flexion and finger extension
C8	Finger flexion
T1	Finger abduction, adduction
Muscle	Nerve Root
Deltoid	C5
Biceps	C6
Wrist extensors	C6
Triceps	C7
Wrist flexors	C7
Finger extensors	C7
Finger flexors	C8
Finger abductors	T1

Lumbar Spine Extrinsic Musculature with Specific Nerve Roots

Lower Extremity	
Nerve Root	Action
	Hip
L1,2,3	Flexion
S1	Extension
L5	Abduction
L2,3,4	Adduction
L2,3,4	Int. Rotation
L4,5, S1,2	Ext. Rotation
	Knee
L4,5, S1	Flexion
L2,3,4	Extension
	Ankle
L4,5	Dorsiflexion
S1,2	Plantar flexion
L4,5, S1	Inversion
L4,5, S1	Eversion

Nerve Root	Action
	MTP Joints
L4,5, S1	Flexion
L4,5, S1	Extension
S1,2	Abduction
S1,2	Adduction
	Toes
L4,5, S1	Flexion H.L.
L4,5, S1	Extension H.L.

Muscle	Nerve Root
Anterior Tibialis	L4
Extensor Digitorum Longus	L5
Peroneus Longus	S1



Heel Walk testing L5.



L5 memory device.



Toe Walk testing S1.



ACHILLE'S **S1** WEAK SPOT

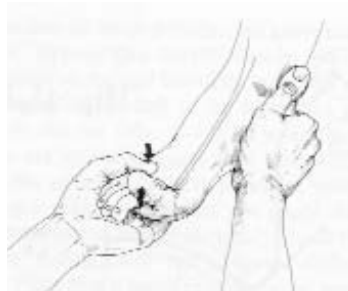
S1 memory device.



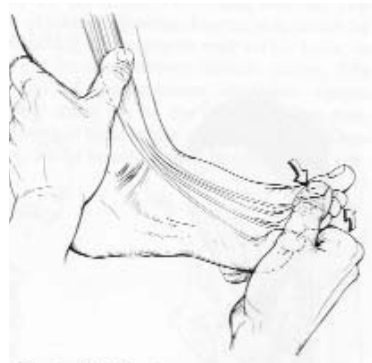
Squat and Rise



Great Toe muscle test L4.



Toe Extension



Ankle Eversion L4-L5



Ankle Inversion L4-L5



Knee Flexion L5-S1



Knee Extension L3-L4





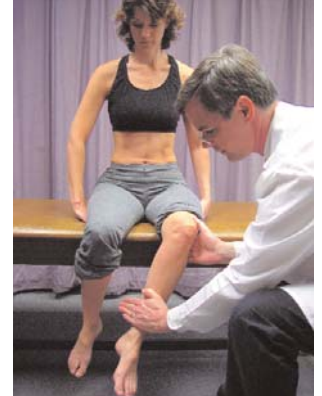
Hip Abduction



Hip Adduction



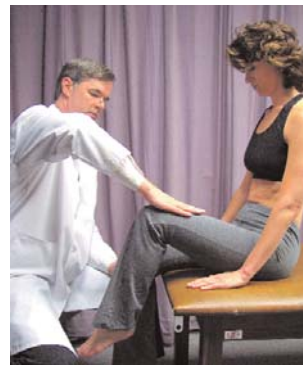
Hip Internal Rotation



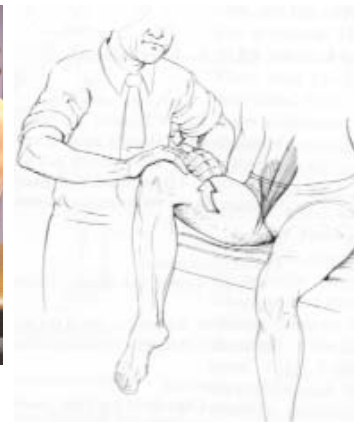
Hip External Rotation



Hip Extension L4-L5



Hip Flexion L2-L3





Elbow Flexion



Wrist Extension



Wrist Flexion



Finger Abduction/Adduction



Finger Flexion