72 Deep Tendon Reflexes

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Definition

In a normal person, when a muscle tendon is tapped briskly, the muscle immediately contracts due to a two-neuron reflex arc involving the spinal or brainstem segment that innervates the muscle. The afferent neuron whose cell body lies in a dorsal root ganglion innervates the muscle or Golgi tendon organ associated with the muscles; the efferent neuron is an alpha motoneuron in the anterior horn of the cord. The cerebral cortex and a number of brainstem nuclei exert influence over the sensory input of the muscle spindles by means of the gamma motoneurons that are located in the anterior horn; these neurons supply a set of muscle fibers that control the length of the muscle spindle itself.

Hyporeflexia is an absent or diminished response to tapping. It usually indicates a disease that involves one or more of the components of the two-neuron reflex arc itself.

Hyperreflexia refers to hyperactive or repeating (clonic) reflexes. These usually indicate an interruption of corticospinal and other descending pathways that influence the reflex arc due to a suprasegmental lesion, that is, a lesion above the level of the spinal reflex pathways.

By convention the deep tendon reflexes are graded as follows:

0 = no response; always abnormal

1+ = a slight but definitely present response; may or may not be normal

2+ = a brisk response; normal

3+ = a very brisk response; may or may not be normal

4+ = a tap elicits a repeating reflex (clonus); always abnormal

Whether the 1+ and 3+ responses are normal depends on what they were previously, that is, the patient's reflex history; what the other reflexes are; and analysis of associated findings such as muscle tone, muscle strength, or other evidence of disease. Asymmetry of reflexes suggests abnormality.

Technique

All of the commonly used deep tendon reflexes are presented here in a group. In a screening examination you will usually find it more convenient to integrate the reflex examination into the rest of the examination of that part of the body; that is, do the upper extremity reflexes when examining the rest of the upper extremity. When an abnormality of the reflexes is suspected or discovered, however, the reflexes should be examined as a group with careful attention paid to the technique of the examination.

Valid test results are best obtained when the patient is relaxed and not thinking about what you are doing. After a general explanation, mingle the specific instructions with questions or comments designed to get the patient to speak at some length about some other topic. If you cannot get any response with a specific reflex—ankle jerks are usually the most difficult—then try the following:

- Several different positions of the limb.
- Get the patient to put slight tension on the muscle being tested. One method of achieving this is to have the patient strongly contract a muscle not being tested.
- In the upper extremity, have the patient make a fist with one hand while the opposite extremity is being tested.
- If the reflex being tested is the knee jerk or ankle jerk, have the patient perform the "Jendrassik maneuver," a reinforcement of the reflex (see Gassel, 1964). The patient's fingers of each hand are hooked together so each arm can forcefully pull against the other. The split second before you are ready to tap the tendon, say "pull."
- In general, any way to distract the patient from what you are doing will enhance the chances of obtaining the reflex. Having the patient count or give the names of children are examples.

The best position is for the patient to be sitting on the side of the bed or examining table. The Babinski reflex hammer (Figure 72.1) is very good. Use a brisk but not painful tap. Use your wrist, not your arm, for the action. In an extremity a useful maneuver is to elicit the reflex from several different positions, rapidly shifting the limb and performing the test. Use varying force and note any variance in response.

Note the following features of the reflex response:

- Amount of hammer force necessary to obtain contraction
- Velocity of contraction
- Strength of contraction
- Duration of contraction
- Duration of relaxation phase
- Response of other muscles that were not tested. When a reflex is hyperactive, that muscle often will respond to the testing of a nearby muscle. A good example is reflex activity of a hyperactive biceps or finger reflex

Figure 72.1
The Babinski reflex hammer.

when the brachioradialis tendon is tapped. This is termed "overflowing" of a reflex.

After obtaining the reflex on one side, always go immediately to the opposite side for the same reflex so that you can compare them.

Jaw Jerk

Place the tip of your index finger on a relaxed jaw, one that is about one-third open. Tap briskly on your index finger and note the speed as the mandible is flexed (see Chapter 61 on the trigeminal nerve).

Biceps Reflex

The forearm should be supported, either resting on the patient's thighs or resting on the forearm of the examiner. The arm is midway between flexion and extension. Place your thumb firmly over the biceps tendon, with your fingers curling around the elbow, and tap briskly. The forearm will flex at the elbow.

Triceps Reflex

Support the patient's forearm by cradling it with yours or by placing it on the thigh, with the arm midway between flexion and extension. Identify the triceps tendon at its insertion on the olecranon, and tap just above the insertion. There is extension of the forearm.

Brachioradialis Reflex

The patient's arm should be supported. Identify the brachioradialis tendon at the wrist. It inserts at the base of the styloid process of the radius, usually about 1 cm lateral to the radial artery. If in doubt, ask the patient to hold the arm as if in a sling—flexed at the elbow and halfway between pronation and supination—and then flex the forearm at the elbow against resistance from you. The brachioradialis and its tendon will then stand out.

Place the thumb of the hand supporting the patient's elbow on the biceps tendon while tapping the brachioradialis tendon with the other hand. Observe three potential reflexes as you tap.

1. Brachioradialis reflex: flexion and supination of the forearm.
2. Biceps reflex: flexion of the forearm. You will feel the biceps tendon contract if the biceps reflex is stimulated by the tap on the brachioradialis tendon.
3. Finger jerk: flexion of the fingers.

The usual pattern is for only the brachioradialis reflex to be stimulated. But in the presence of a hyperactive biceps or finger jerk reflex, these reflexes may be stimulated also.

Finger Jerk

Have the patient gently curl his fingers over your index finger, much as a bird curls its claws around the branch of a tree. Then raise your hand, with the patient's hand now being supported by the curled fingers. Tap briskly on your fingers so that the force will transmit to the patient's curled fingers. The response is a flexion of the patient's fingers.

Knee Jerk

Let the knees swing free by the side of the bed, and place one hand on the quadriceps so you can feel its contraction. If the patient is in bed, slightly flex the knee by placing your forearm under both knees by contraction of the quadriceps with extension of the lower leg. If the reflex is hyperactive there is sometimes concomitant adduction of the ipsilateral thigh. Adduction of the opposite thigh and extension of the opposite lower leg also can occur simultaneously if those reflexes are hyperactive. Note that this so-called crossed thigh adduction or leg extension tells you that the reflexes in the opposite leg are hyperactive. They tell you nothing about the state of the reflex in the leg being tested. Use the Jendrassik maneuver if there is no response.

Ankle Jerk

With the patient sitting, place one hand underneath the sole and dorsiflex the foot slightly. Then tap on the Achilles tendon just above its insertion on the calcaneus. If the patient is in bed, flex the knee and invert or evert the foot somewhat, cradling the foot and lower leg in your arm. Then tap on the tendon.

If no response is obtained, have the patient face a chair and kneel on it with the knees resting against the back of the chair, the elbows on the top of the back, and the feet projecting over the seat. First dorsiflex the foot slightly and tap on the tendon. Use the Jendrassik maneuver if this doesn't work. This position is well suited to observing the relaxation phase of the reflex in patients with suspected thyroid disease.

See DeJong (1967) for a description of numerous other reflexes that are useful in certain situations.

Basic Science

A stretch reflex is the contraction of a muscle in response to stretching of muscle spindles, which are receptors that lie in parallel with extrafusal muscle fibers. The reflex is composed of a two-neuron arc. The afferent neuron, whose cell body is in a sensory ganglion, innervates the spindle. When the muscle spindle is stretched, this neuron fires and monosynaptically excites alpha motoneurons in the anterior horn of the spinal cord. This alpha motoneuron is the second neuron; it supplies the muscle that is being tapped or transiently stretched. The detailed mechanisms underlying the operation of the spindle are quite complex, but considerable knowledge about them is now available in the literature, and new details are added constantly. The muscle spindle is a slender, spindle-shaped structure that is intermingled with the usual muscle fibers. Each spindle is composed of two types of elongated, poorly staining fibers: nuclear bag fibers and nuclear chain fibers. Each contains multiple nuclei. Six to ten of these fibers lie within the spindle's connective tissue sheath. They are called "intrafusal" muscle fibers, since they lie inside the fusiform structure, in contrast to the surrounding "extrafusal" fibers that make up the contractile element of muscle.

Afferent sensory terminals that innervate the spindle fibers are of two types: primary and secondary (Figure 72.2). The spindles fire according to the velocity and amount of stretch placed upon the central nuclear regions of the intrafusal fibers. The degree of stretch communicated to the central portion of the fibers is determined by two factors: the length and change in length of the surrounding extrafusal fibers (see Figure 72.2) and the degree of contraction of the intrafusal fibers (see below).

Impulses from the spindle receptors enter the dorsal horn where the information takes four routes: (1) to the cortex; (2) to synapse directly on an alpha motoneuron, which causes immediate contraction of the muscle innervated by the spindle, the agonist; (3) to synapse on an inhibitory neuron which in turn synapses on an alpha motoneuron that goes to a muscle antagonistic to the one innervated by the spindle—thus there is concomitant relaxation of the antagonist as the agonist contracts; and (4) to the cerebellum via the dorsal spinocerebellar tracts.

The previous paragraph describes the course taken by the afferent impulses from the sensory nuclei of the muscle spindles. Recall now that the second component of the spindle was a contractile element, the intrafusal fibers. The firing of the spindle afferents is dependent upon the length of the extrafusal fibers (as outlined above) and the length of the intrafusal fibers. The contraction of the ends of intrafusal fibers and thus the strength of the central portions are controlled by gamma motoneurons: these small neurons are located in the anterior horn and are influenced by the cerebellum, the cortex, and various brainstem nuclei. The probable function of this motor innervation of a sensory structure is to enable these supraspinal structures to "set" and thus ultimately regulate the sensitivity of the spindle. The higher centers and, in particular, the cortex thereby get sensory information from the muscle spindles and, in turn, through the gamma motoneuron, control the amount and quality of information received.

The Golgi tendon organ, which is the second major muscle receptor, is attached between the extrafusal fibers and the tendon. Thus the tendon organ is in series with the extrafusal fibers and will fire as the muscle contracts. The spindles, in contrast, are parallel with (i.e., alongside) the extrafusal fibers and so fire when the extrafusal fibers relax (i.e., are stretched). The impulses from the tendon organ go through the dorsal horn and synapse on an inhibitory interneuron which in turn synapses on an alpha motoneuron that goes to the agonist. Therefore the tendon organ ultimately causes relaxation of the agonist and, by way of interneurons, a facilitation of the antagonist. Information is also conveyed from these receptors to the cerebellum and cortex.

The spinal reflexes that are set up by the mechanisms

Muscle Receptors	Fiber types	Pathways	Sensory endings	Gamma Motoneurons (efferents to spindles)
Muscle spindle	Nuclear bag fiber	Cerebellum Cortex Muscle spindle: Afferent component → Dorsal horn Ventral horn: Efferent component 1 Alpha motoneuron → Agonist muscle 2. Inhibitory interneuron → Alpha motoneuron → Antagonist muscle 3. Gamma motoneuron → Efferent component	Lie in parallel with extrafusal fibers Sensory endings: Group 1a "primary ending" Synonym: annulospiral ending Gives information about length and velocity of extension of muscle: Dynamic firing: spindle firing is greatest while muscle is lengthening, firing ceases with contraction and is reduced with steady lengths below that seen during the stretching process	Small anterior horn motoneurons that receive descending cortical impulses and then send efferent axons to the muscle spindles (see diagram under Pathways). As they fire there is a contraction of the intrafusal fibers of the muscle spindle. This causes a stretching of the central part of the spindle where the sensory fibers are, and consequently the sensory fibers fire. This setup probably allows supraspinal structures to regulate the sensitivity of the muscle spindles, or their background firing levels.
	Nuclear chain fiber	As above, with the exception that the excitatory reflex pathway may involve one or more interneurons.	Lie in parallel with extrafusal fibers Sensory endings Group 1a as above Group II "secondary ending" Synonym. flower-spray ending Gives information about length and velocity of extension of muscle: Static firing: response greatest when stretch is constant after contraction has ceased.	Gamma dynamic motoneurons supply group 1 primary endings and increase their responsiveness to velocity of spindle elongation. Gamma static motoneurons supply group 1 and group 2 endings and increase their levels of firing in response to steady stretches
Golgi tendon organ		Tendon organ → Dorsal horn Ventral horn Facilitatory interneuron → Alpha motoneuron → Antagonist muscle Inhibitory interneuron → Alpha motoneuron → Agonist muscle	Lie in series with extrafusal fibers, since they are attached to tendons. Sensory endings: Group 1b Gives information about muscle tension: fires briskly during contraction, but little during passive elongation of the muscle.	

Figure 72.2
Summary of muscle spindles and tendon organs.

described above serve the function of keeping the muscle fibers adjusted to a certain length and to a certain tension, thereby maintaining muscle tone and ultimately limb posture.

Clinical Significance

Absent stretch reflexes indicate a lesion in the reflex arc itself. Associated symptoms and signs usually make localization possible:

1. Absent reflexes and sensory loss in the distribution of the nerve supplying the reflex: the lesion involves the afferent arc of the reflex—either nerve or dorsal horn.
2. Absent reflex with paralysis, muscle atrophy, and fasciculations: the lesion involves the efferent arc—anterior horn cells or efferent nerve, or both.

Peripheral neuropathy is today the most common cause of absent reflexes. The causes include diseases such as diabetes, alcoholism, amyloidosis, uremia; vitamin deficiencies such as pellagra, beriberi, pernicious anemia; remote cancer; toxins including lead, arsenic, isoniazid, vincristine, diphenylhydantoin. Neuropathies can be predominantly sensory, motor, or mixed and therefore can affect any or all components of the reflex arc (see Adams and Asbury, 1970, for a good discussion). Muscle diseases do not produce a disturbance of the stretch reflex unless the muscle is rendered too weak to contract. This occasionally occurs in diseases such as polymyositis and muscular dystrophy.

Hyperactive stretch reflexes are seen when there is interruption of the cortical supply to the lower motor neuron, an "upper motor neuron lesion." The interruption can be anywhere above the segment of the reflex arc. Analysis of associated findings enables localization of the lesion.

The stretch reflexes can provide excellent clues to the level of lesions along the neuraxis. Table 72.1 lists the segmental innervation of the common stretch reflexes. For example, if the biceps and brachioradialis reflexes are normal, the triceps absent, and all lower reflexes (finger jerk, knee jerk, ankle jerk) hyperactive, the lesion would be located at the C6–C7 level, the level of the triceps reflex. The reflex arcs above (biceps, brachioradialis, jaw jerk) are functioning normally, while the lower reflexes give evidence of absence of upper motor neuron innervation.

The laterality of reflexes is also helpful. For example, if all the reflexes on the left side of the body are hyperactive and those on the right side are normal, then a lesion is interrupting the corticospinal pathways to that side somewhere above the level of the highest reflex that is hyperactive.

Individual nerve and root lesions can be identified by using information about the reflexes along with sensory and motor findings. *Aids to the Investigation of Peripheral Nerve Injuries* is a valuable pamphlet to carry in your bag to help in testing and analyzing muscles with respect to their innervation.

Table 72.1
Segmental Innervation of Stretch Reflexes

Reflex	Nerve or root
Jaw jerk	Trigeminal nerve
Biceps	C5–C6
Brachioradialis	C5–C6
Triceps	C6–C7
Finger jerk	C8–T1
Knee jerk	L3–L4
Ankle jerk	S1

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