CHAPTER 38

The Deep Tendon or Muscle Stretch Reflexes

When a normal muscle is passively stretched, its fibers resist the stretch by contracting. The stretch may be caused by gravity, manipulation, or other stimuli. In reflex responses, the contraction results from stimulation of the sensory organs in the muscle, either directly or indirectly through a stimulus applied to its tendons, the bone to which it is attached, or the overlying skin. In the monosynaptic stretch reflex, sudden lengthening stretches the muscle spindles, which send impulses via the primary spindle afferents into the spinal cord. The spindle afferents synapse directly, without participation of any interneuron, on the alpha motor neurons innervating the muscle, causing a reflex contraction of the muscle (Figure 32.1). This sequence of lengthening, contraction, and then relaxation is a stretch (tendon, deep tendon, muscle stretch, myotatic, or proprioceptive) reflex. Some muscles react more strongly than others.

Stretch reflexes serve a protective function, particularly in standing and walking; they help to counter any sudden unexpected forces. Because of their critical roles in maintaining an erect posture, the extensor muscles of the legs, quadriceps and calf muscles, have better developed stretch reflexes than the flexors. This important physiology is exploited clinically by applying an artificial stretch by striking the tendon of the muscle with a reflex hammer.

Reflexes elicited by application of a stretch stimulus to either tendons or periosteum or occasionally to bones, joints, fascia, or aponeurotic structures are usually referred to as muscle stretch or deep tendon reflexes (DTRs). The reflex is caused by sudden muscle stretch brought about by percussion of its tendon. Occasionally, the tendon is stretched by percussing a structure to which it is attached, as in the jaw jerk. The term deep helps separate these reflexes from the superficial or cutaneous reflexes, which are quite different. Some authorities criticize the term deep tendon reflex, contending it implies the receptor is in the tendon, which is of course inaccurate. This link between the term and the location of the receptor is in the mind and opinion of the critic. Erb introduced the term tendon reflex in 1875. In 1885, Gowers recommended the term be discarded. So, for over 100 years, it has been fashionable to rail against the term DTR. It is difficult to pick up a text on the neurologic examination without encountering at least a barb if not a screed on this point. In fact, the term DTR is in much wider use than muscle stretch reflex (MSR). Many more physicians are familiar with the DTR acronym than with MSR. Most physicians encountering the abbreviation MSR would think it was some Chinese cooking spice, but nearly everyone recognizes DTR, neurologist and nonneurologist alike. Gowers offered the term myotatic (Gr. myo, "muscle" + tatic "to stretch"), but many neurologists, not to mention other physicians, would pause and puzzle over this formal, obfuscatory term. For both pragmatic and antipedantic reasons, the DTR abbreviation is used in this text.

The primary problem areas in eliciting DTRs are poor tools and poor technique. These reflexes are best tested using a high-quality rubber percussion hammer. To properly obtain a reflex, a crisp blow must be delivered to quickly stretch the tendon. A heavy, high-quality reflex hammer is immensely helpful for this task, but many physicians use the cheapest hammer they can find, usually poor, pitiable, and inferior instruments. The worst possible hammers are drug company giveaway Taylor (tomahawk) hammers; they have no heft and are worth just what was paid for them. A genuine, high-quality, purchased Taylor is the lowest level of acceptable hammer, and these are

often inadequate in the hands of novices. A variety of good hammers are available at reasonable prices. Other objects are sometimes used, and it seems a point of honor among some physicians to use anything but a reflex hammer. They substitute fingers, the edge of a stethoscope or anything else handy, sometimes to the point of absurdity. The reliability of such a reflex examination mirrors the effort put into using a proper instrument. A soft rubber hammer is most desirable. A blow with an ancient, desiccated, stony hard hammer may cause pain for the patient and interfere with the response. The hammer should never leave bruises on either the patient or the examiner.

Proper technique is much more difficult to describe than to demonstrate. The hammer strike should be quick, direct, crisp, and forceful, but no greater than necessary. The most effective blow is delivered quickly with a flick of the wrist, holding the handle of the hammer near its end and letting it spin through loosely held fingertips. Putting the index finger on top of the handle and using primarily elbow motion, common faults, make it much harder to achieve adequate velocity at the hammer head. Another common mistake is "pecking": striking the tendon with a timid, decelerating blow, pulling back at the last instant.

The patient should be comfortable, relaxed, and properly positioned. It may help relaxation to divert the patient's attention with light conversation. The optimal position is usually about midway in the range of motion of the muscle to be tested. Sometimes, as in the ankle reflex, positioning includes passively stretching the muscle slightly. An adequate stimulus must be delivered to the proper spot. Reinforcement methods are necessary if the reflex is not obtainable in the usual way. The part of the body to be tested should be in an optimal position for the response. In order to compare the reflexes on the two sides of the body, the position of the extremities should be symmetric. During the reflex examination, the patient should keep the head straight, since looking to one side, as is the temptation, may alter reflex tone, especially in the arms (tonic neck reflex). The DTRs may be influenced to some degree by voluntary mental effort. Merely by concentrating, some individuals are able to somehow alter reflex excitability. Mentally induced reflex asymmetry is possible and may be clinically relevant in some cases.

The examiner can feel as well as see the contraction. Placing one hand over the muscle is often useful, especially when responses are sluggish. A reflex quadriceps contraction can sometimes be felt even when insufficient to produce visible contraction or knee movement. The activity of a reflex is judged by the speed and vigor of the response, the range of movement, and the duration of the contraction. An absent reflex often makes a dull, thudding sound when the tendon is struck.

TABLE 38.1 The Commonly Elicited Deep Tendon (Muscle Stretch) Reflexes

Reflex	Segmental Level	Peripheral Nerve
Biceps	C5-C6	Musculocutaneous
Triceps	C7-C8	Radial
Brachioradialis	C5-C6	Radial
Quadriceps	L3-L4	Femoral
Achilles	51	Sciatic

The DTRs usually examined include the biceps, triceps, brachioradialis, knee (quadriceps), and ankle (Achilles) tendon reflexes. Other DTRs are occasionally useful. Table 38.1 summarizes the reflex levels. Reflexes may be graded as absent, sluggish or diminished, normal, exaggerated, and markedly hyperactive. For the purposes of clinical note taking, most neurologists grade the DTRs numerically as follows: 0 = absent; 1+ (or +) = present but diminished; 2+ (or ++) = normal; 3+ (or +++) = increased but not necessarily to a pathologic degree; and 4+ (or ++++) = markedly hyperactive, pathologic, often with extra beats or accompanying sustained clonus (see Chapter 40). The "+" after the number is more traditional than informative and is sometimes omitted. Signs are sometimes used to indicate subtle asymmetry, but generally, a grade of 2 means the same as 2+. Another level, trace (or +/–), is frequently added to refer to a reflex, most often an ankle jerk, that appears absent to routine testing but can be elicited with reinforcement (see p. 471). Some add a grade of 5+ for the patient with extreme spasticity and clonus. In the 0 to 4 scale, level 1+ DTRs are still normal but somewhat sluggish and difficult to elicit and hypoactive but, in the examiner's opinion, not pathologic. Grade 3+ reflexes are "fast normal," quicker than 2+, sometimes very quick, but not accompanied by any other signs of upper motor neuron pathology such as increased tone, upgoing toes, or sustained clonus. Normality of the superficial reflexes, normal lower-extremity tone, and downgoing toes are reassuring evidence of fast normal rather than pathologically quick reflexes. Some use 3+ to indicate the presence

TABLE 38.2 Method of Recording the Commonly Tested Muscle Stretch Reflexes

	Right	Left
Biceps	2+	2+
Triceps	2+	2+
Brachioradialis	2+	2+
Patellar	2+	2+
Achilles	2+	2+
Plantar	Down	Down

Grades 0 to 4+ (see text) used for all plantar reflex, which is down (normal), absent (0), equivocal (+/-) or up (abnormal). Other reflexes may be added and charted as needed.

of spread or unsustained clonus, with all other normal reflexes, even very fast ones, labeled as 2+. Grade 4+ reflexes are unequivocally pathologic. The speed of the response is very fast, the threshold low, and the reflexogenic zone wide, and there are accompanying signs of corticospinal tract dysfunction. Other scales are in use, but not widely. The Mayo clinic utilizes a scale in which 0 is normal and reflexes are either increased (1+ to 4+) or decreased (1– to 4–). Reflexes may be charted in several ways, for example, as shown in Table 38.2, or as in Figure 38.1. When reflexes are very active, responses may occur from muscles that have not been directly stretched, even in normal patients. The response may involve adjacent or even contralateral muscles, and the contraction of one muscle may be accompanied by contraction of other muscles. This is referred to as spread, or irradiation, of reflexes. It is normal for percussion of the brachioradialis tendon to also cause slight finger flexion. In the presence of spasticity and hyperreflexia, contraction of the biceps or brachioradialis may be accompanied by pronounced flexion of the fingers and adduction of the thumb. Extension of the knee may be accompanied by adduction of the hip, or there may be bilateral knee extension. Judging how much spread is still within normal limits can be difficult. Under some circumstances, the expected response to percussion of a tendon is absent, but muscles innervated by adjacent spinal cord segments contract instead (e.g., inverted brachioradialis reflex) (see Inverted and Perverted Reflexes). On other occasions, a reflex is absent and percussion of the tendon causes an inverted or paradoxical contraction (e.g., elbow flexion on attempted elicitation of the triceps reflex).

In some patients, DTRs may be markedly diminished, or even apparently absent, although there is

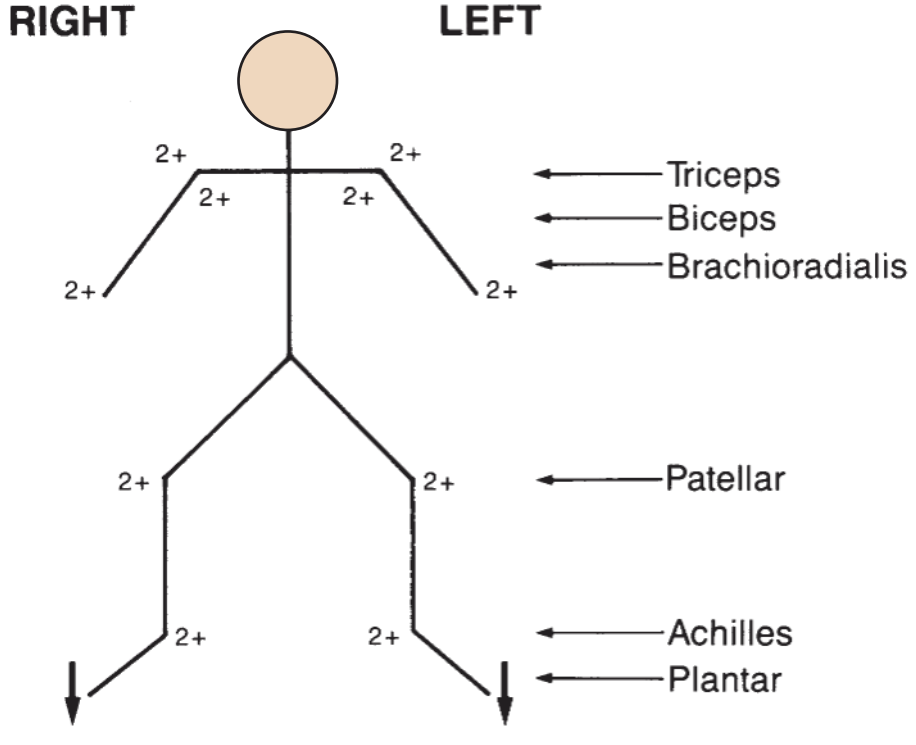

FIGURE 38.1 Alternate method of recording the commonly tested muscle stretch reflexes. For grading, see text and Table 38.2.

no other evidence of nervous system disease. Under such circumstances, reinforcement techniques are often useful. Reflex reinforcement probably involves supraspinal, fusimotor, and long-loop mechanisms. A reflex can be reinforced or brought out using several methods. In the Jendrassik maneuver, the patient attempts to pull the hands apart with the fingers flexed and hooked together, palms facing, as the tendon is percussed (Figure 38.2). The effect is very brief, lasting only 1 to 6 seconds, and is maximal for only 300 milliseconds. The Jendrassik maneuver is obviously only useful for lower-extremity reflexes. Other techniques include having the patient clench one or both fists, firmly grasp the arm of the chair, side of the bed, or the arm of the examiner. Reinforcement may also be carried out by having the patient look at the ceiling, grit the teeth, cough, squeeze the knees together, take a deep breath, count, read aloud, or repeat verses at the time the reflex is being tested. A sudden loud noise, a painful stimulus elsewhere on the body—such as the pulling of a hair or a bright light flashed in the eyes—may also be a means of reinforcement.

Procedures other than distraction are also helpful in reflex reinforcement. A slight increase in tension of the muscle being tested may reinforce the reflex response. A simple and effective method to reinforce a knee or ankle jerk is to have the patient maintain a slight, steady contraction of the muscle whose tendon is being tested (e.g., slight plantar flexion by pushing the ball of the foot against the floor or the examiner's hand to reinforce the ankle jerk). The patient may tense the quadriceps by extending the knee slightly against resistance as the knee jerk is being elicited. Reinforcement may increase the amplitude of a sluggish reflex or bring out a latent reflex not otherwise obtainable. Reflexes that are normal on reinforcement, even though not present without reinforcement, may be considered normal. Slight muscle contraction due to inability to relax may be one reason for the slightly hyperactive reflexes often seen in patients who are tense or anxious.

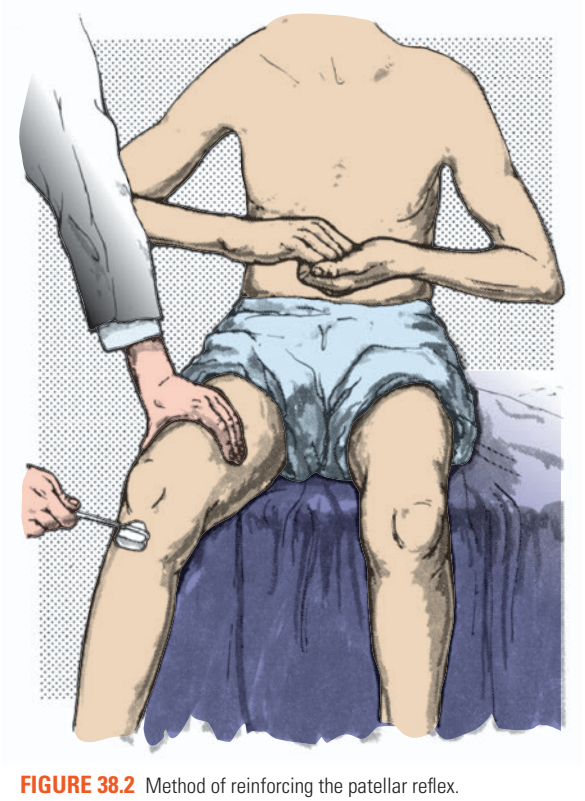

FIGURE 38.2 Method of reinforcing the patellar reflex.

The DTRs are instrumental in the evaluation of weakness. Under most circumstances, weakness accompanied by hyporeflexia is of lower motor neuron origin, and weakness accompanied by hyperreflexia of upper motor neuron origin. The presence of pathologic reflexes (see Chapter 40) and abnormalities of associated movements (see Chapter 42) are also helpful in the differential diagnosis (Table 38.3). The following sections discuss the upper-extremity, trunk, and lower-extremity reflexes. The masseter or mandibular reflex (jaw jerk) is covered in Chapter 15.

THE UPPER-EXTREMITY REFLEXES

The biceps, triceps, brachioradialis, and finger flexor reflexes are the most important upper-extremity reflexes.

The Biceps Reflex

With the arm relaxed and the forearm slight pronated and midway between flexion and extension, the examiner places the palmar surface of her extended thumb or finger on the patient's biceps tendon and then strikes the extensor surface with the reflex hammer (Figure 38.3). Pressure on the tendon should be light; too much pressure exerted with the thumb or finger against the tendon makes the reflex much harder to obtain. The hands may lie in the patient's lap, or the examiner may hold the patient's arm with the elbow resting in her hand. The major response is a contraction of the biceps muscle with flexion of the elbow. Since the biceps is also a supinator, there is often a certain amount of supination. If the reflex

TABLE 38.3 Reflex Patterns with Different Neurologic Disorders

Site or Type of Lesion	Muscle Stretch Reflexes	Superficial Reflexes	Pathologic Reflexes	Associated Movements
Neuromuscular junction	Normal or decreased	Normal	Absent	Normal
Muscle	Usually normal; may be decreased in proportion to weakness	Normal	Absent	Normal
Peripheral nerve	Decreased to absent	Normal, or decreased to absent in distribution of involved nerve(s)	Absent	Normal
Corticospinal tract (upper motor neuron syndrome)	Hyperactive (especially in speed or response)	Decreased to absent	Present	Pathologic associated movements present
Extrapyramidal system	Normal; occasionally slightly increased or decreased	Normal or slightly increased	Absent	Normal associated movements absent
Cerebellum	Pendular	Normal	Absent	Normal
Psychogenic	Normal or increased (especially in range of response)	Normal or increased	Absent	Normal or bizarre

is exaggerated, the reflexogenic zone is increased and the reflex may even be obtained by tapping the clavicle; there may be abnormal spread with accompanying flexion of the wrist and fingers and adduction of the thumb.

The Triceps Reflex

This reflex is elicited by tapping the triceps tendon just above its insertion on the olecranon process of the ulna. The arm is placed midway between flexion and extension and may be rested in the patient's lap, on her thigh or hip, or on the examiner's hand (Figure 38.4). The response is contraction of the triceps muscle with extension of the elbow. The most common error in eliciting the triceps jerk is simply too timorous a blow. The paradoxical or inverted triceps jerk consists of flexion of the elbow with percussion of the triceps tendon. This response

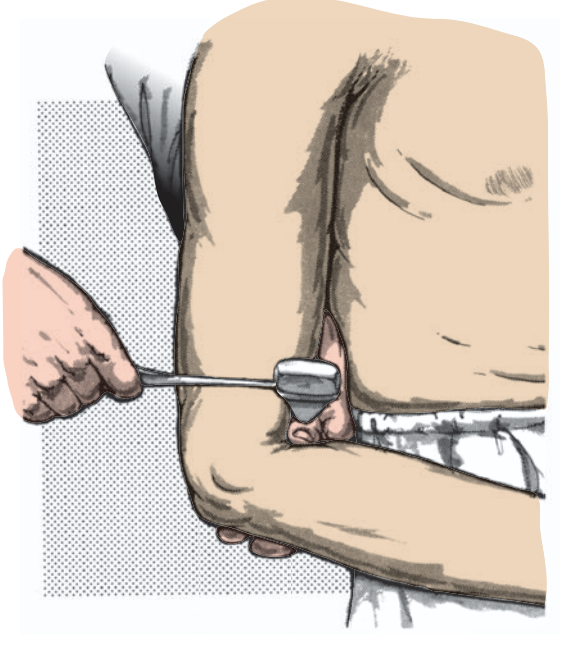

FIGURE 38.3 Method of obtaining the biceps reflex.

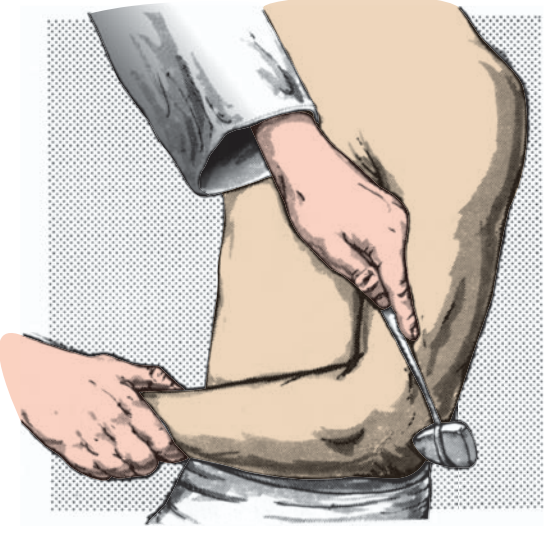

FIGURE 38.4 Method of obtaining the triceps reflex.

radiculopathy. If due to neuropathy, the external hamstring will usually be preserved, but in radiculopathy, it may be depressed in concert with the ankle reflex.

The Tensor Fascia Lata Reflex (Superior Gluteal Nerve, L4-S1)

This reflex is tested by tapping over the origin of the tensor fascia lata near the anterior superior iliac spine, with the patient recumbent. The response consists of slight abduction of the thigh.

The Gluteal Reflexes

Tapping the lower portion of the sacrum or the posterior aspect of the ilium near the origin of the gluteus maximus muscle is followed by a contraction of the muscle and extension of the thigh. This reflex is best tested with the patient recumbent, with her weight on the opposite side, so there is moderate flexion of the ipsilateral thigh; it may also be elicited with the patient prone. The reflex is mediated by the inferior gluteal nerve (L5-S2). A gluteus medius reflex may on occasion be elicited by striking the anterior iliac crest near the site of origin of the muscle. The response is slight abduction and medial rotation of the hip. The innervation is the same as for the tensor fascia lata reflex and the response almost identical; it may not be possible to differentiate these two reflexes.

The Extensor Hallucis Longus Reflex

Using a finger, the examiner pushes down on the dorsal surface of the great toe; tapping the finger is followed by extension of the toe that may be felt more than seen. This reflex is mediated by the deep peroneal nerve, primarily by the L5 nerve root. The response may be absent in L5 radiculopathy.

The Tibialis Posterior Reflex (Tibial Nerve, L5-S1)

Tapping the tendon of the tibialis posterior just above and behind the medial malleolus is followed by inversion of the foot. This reflex is best examined with the patient prone and the foot, in a neutral position or in slight eversion, extended beyond the edge of the bed. The leg should be supported by the examiner and slightly flexed at the knee. It may be absent in L5 or S1 radiculopathy.

The Peroneal (Tibialis Anterior) Reflex

With the patient's foot plantar flexed and inverted, the examiner presses a finger firmly over the distal ends of the first and second metatarsal bones. A brisk tap to the finger is followed by eversion and dorsiflexion of the foot. The reflex is due to contraction of muscles supplied by the deep and superficial peroneal nerves (L4-S1).

The Plantar Muscle Reflexes

There are numerous reflexes in which the response is flexion of the toes. These are difficult to elicit in normal individuals, of limited clinical significance, and of importance only when exaggerated. They are discussed with the pathologic reflexes in Chapter 40.

INTERPRETATION OF THE DEEP TENDON (MUSCLE STRETCH) REFLEXES

The most valuable DTRs for clinical diagnosis are the biceps, triceps, brachioradialis, patellar, and Achilles (see Table 38.1); under most circumstances, and using good technique, these are elicitable in every normal person. One or more of these reflexes may be absent in occasional individuals with no other evidence of disease of the nervous system. They are present even in the majority of premature infants. The activity of a DTR is judged by the threshold, latency, speed, vigor and duration of contraction, the range of movement, and whether there is spread or irradiation of the reflex. Of these, the latent period between the time the stimulus is applied and the time the response occurs is most important for clinical evaluation of disease states. Accurate evaluation of the reflex responses obviously depends on the experience of the examiner. By far, the most important factor is the diligence and practice expended in learning the techniques. The appraisal depends on the individual interpretation of the examiner. There is no standard, and there is a certain amount of normal variation in reflex activity. What is normal for one individual may be an increased or a decreased response for another. In some persons, the reflexes are lively; in others, they are sluggish. Under normal circumstances, the reflexes should be equal on the two sides.

ABNORMALITIES OF THE DEEP TENDON (MUSCLE STRETCH) REFLEXES

Abnormal DTRs are either hypoactive or hyperactive. When hypoactive, the response varies from diminished or sluggish to complete absence of the reflex. Hyperactive reflexes are characterized by varying degrees of decreased latency, increased speed and vigor of response, increased range of movement, decrease in threshold, extension of the reflexogenic zone, and prolongation of the muscular contraction. The pathologic conditions in which these various changes occur are discussed in the following sections. Table 38.3 summarizes the patterns of reflex responses seen with lesions at various sites.

Reflexes are judged in both absolute and relative terms. Clearly hyperactive or hypoactive reflexes speak for themselves. But a reflex that is normal in absolute terms may be judged abnormal in comparison to the patient's other reflexes. The reflexes should be compared on the two sides of the body, the arms to the legs, and the knees to the ankles. The DTRs are normally symmetric, and reflexes otherwise normal may be abnormal if different from expected. For example, a 1+ biceps jerk in a patient with suspected cervical radiculopathy, while "normal," may be judged abnormal if the opposite biceps jerk is 2+. The DTRs are usually comparable in the upper and lower extremities. Slight differences are permissible, but a pronounced difference may be significant (e.g., in thoracic myelopathy, the DTRs in the legs may be much brisker than in the arms, even though not clearly pathologic). A proximal to distal gradient may also be significant. Symmetric 1+ ankle jerks when all of the other reflexes are 2+ may signal mild peripheral neuropathy. When asymmetry is the main finding, it is sometimes difficult to tell whether one side is increased or the other side decreased.

Hypoactive Reflexes

When a reflex is hypoactive, there is a sluggish response and/or a diminution in the range of response. An increase in stimulus intensity may be necessary to elicit the reflex, or repeated blows may be necessary, for a single stimulus may be subliminal. A DTR is absent if it is not obtained even with reinforcement. A depressed or absent reflex results from dysfunction of some component of the reflex arc. Interference with the afferent limb may be caused by lesions involving the sensory nerve, posterior root, dorsal root ganglion, or intramedullary pathways between the dorsal root entry zone and the anterior horn (e.g., syringomyelia). Abnormalities of the motor unit and final common pathway that make up the efferent limb of the reflex arc occur in many conditions, but particularly with radiculopathy and peripheral nerve lesions. In neurogenic processes, DTRs are lost out of proportion to atrophy and weakness. With a peripheral nerve lesion, a reflex may not return until much of the motor function has been recovered. Sometimes there is persistent areflexia following lesions of the nerve root or peripheral nerve, even after complete return of both motor and sensory functions. In myasthenia gravis, the reflexes are affected only when there is severe and extensive involvement, but in Lambert-Eaton syndrome, depressed reflexes are common. In periodic paralysis, DTRs may be temporarily absent during attacks. In myopathies, reflexes are lost in proportion to the atrophy and weakness. When atrophy and weakness are severe, reflexes may disappear. In many forms of muscular dystrophy, the proximal reflexes disappear early, while the distal reflexes may persist until the later stages of the disease.

The DTRs may also be decreased or absent in various other conditions. They are often absent in deep coma, narcosis, heavy sedation, and deep sleep. They are characteristically absent during nerve block, caudal anesthesia, and spinal anesthesia. They are absent in spinal shock following a sudden transverse lesion of the spinal cord but reappear below the level of the lesion after a period of 3 to 4 weeks and usually become hyperactive. In Adie's syndrome, the tonic pupils are accompanied by depressed or absent reflexes.

A prolonged relaxation phase causing a "hung-up" reflex, especially of the ankle jerk, is a classical finding of hypothyroidism (Woltman's sign); the reflexes return to normal with treatment. But most patients with seemingly hung-up ankle jerks are euthyroid. Relaxation slows with advancing age, more so in females. Slow contraction and relaxation times may also occur with other conditions, including lower motor neuron disease. Delayed relaxation may also occur in myotonic disorders. In diabetic neuropathy, there may be either prolongation of the reflex time or decrease or absence of the reflexes before there is other evidence of nervous system involvement. The reflexes may appear to be decreased

or absent in neurologic disorders in which there is marked spasticity or rigidity with contractures and in diseases of the joints characterized by inflammation, contractures, and ankylosis. The apparent hyporeflexia is due to lack of motility at the joint or pain on moving the joint; careful observation may disclose a muscle contraction even though there is no movement at the joint.

Hyperactive Reflexes

Reflex hyperactivity is characterized by the following: a decrease in reflex threshold; a decrease in the latency, the time between tendon percussion, and the reflex contraction; an exaggeration of the power and range of movement; prolongation of the reflex contraction; extension of the reflexogenic zone (or zone of provocation); and spread of the reflex response. When the reflex threshold is decreased, a minimal stimulus may evoke the reflex, and reflexes that are not normally obtained may be elicited with ease. Very hyperactive DTRs may sometimes be elicited with extremely slight percussion. Another manifestation of decreased reflex threshold may be a widening of the area from which the reflex may be elicited, and application of the stimulus to sites at some distance from the usual one may evoke the response; the patellar reflex may be elicited by tapping the tibia or dorsum of the foot, and the biceps and other arm reflexesby tapping the clavicle or scapula. There may also be abnormal spread of the response. One stimulus may provoke repetitive responses and sometimes elicit sustained clonus.

The DTRs become hyperactive with lesions of the corticospinal or pyramidal system. Spasticity and hyperreflexia are likely related to involvement of a variety of structures in the descending motor pathways at cortical, subcortical, midbrain, and brainstem levels. Hyperreflexia results from a lowering of the reflex threshold due to increased excitability of the lower motor neuron pool related to dysfunction of some or all of these structures. From a clinical point of view, the terms pyramidal, corticospinal, or upper motor neuron are used to encompass these changes. A lesion at any level of the corticospinal system or other related upper motor neuron components, from the motor cortex to just above the segment of origin of a reflex arc, will be accompanied by spasticity and hyperreflexia. The characteristic posture in hemiplegia is flexion of the upper extremities, with more marked weakness of the extensors, and extension of the lower extremities, with more marked weakness of the flexors. Consequently, the flexor reflexes are exaggerated to a greater degree in the upper extremities, and the extensor reflexes in the lower. The reflexes may be present in spinal cord lesions in spite of the absence of sensation. A reflex may be increased if the tone of the antagonist muscle is diminished (e.g., an increased knee jerk may occur if there is weakness of the hamstrings).

Exaggeration of the DTRs may occur in psychogenic disorders and in anxiety, fright, and agitation (Table 38.3). The reflexes vary in these conditions; they may be normal, or they may be decreased owing to voluntary or involuntary tension of the antagonistic muscle, but they are most frequently increased. Hyperactivity may be marked, but it is an exaggeration not in the speed or threshold of the response but in the excursion or range of response. The foot may be kicked far into the air and held extended for a time after the patellar tendon is tapped, but the contraction and relaxation takes place at a normal rate. There is often a bilateral response with extraneous and superfluous jerking of remote parts, including whole body jerks, when a reflex is tested. There is no increase in the reflexogenic zone in psychogenic lesions, and although there may be irregular repeated jerky movements (spurious clonus), no true clonus is present. Furthermore, there are no other signs of organic disease of the corticospinal system.

In lesions of the extrapyramidal system, there are no consistent reflex changes (Table 38.3). The activity of the response depends on the level of muscle tone and the amount of rigidity that is present. Usually, the reflexes are slightly exaggerated, owing to increased muscle tone, but this is not a consistent finding. Rigidity may cause depression or absence of the reflexes. In diseases of the cerebellum, the reflexes may be diminished (Table 38.3) and pendular: Eliciting the patellar reflex while the foot is hanging free may elicit a series of to-and-fro pendular movements of the foot and leg before the limb finally comes to rest. The increased swinging may result from hypotonia of the extensor and flexor muscles and a lack of the restraining influence they normally exert on each other. The pendular response may also be observed in chorea, but there is more frequently a "hung" reflex: If the patellar tendon is tapped while the foot is hanging free, the knee may be held in extension for a few seconds before relaxing because of prolonged contraction of the quadriceps. In chorea, the response may not be obtained until the stimulus has been applied a number of times.