Posture and Equilibrium

■ DEFINITION

Subconscious **adjustment of tone** in different muscles in relation to every movement is known as the **posture.** Significance of posture is to make the movement smooth and accurate and to maintain the line of gravity constant or to keep the body in equilibrium with line of gravity. Posture is not an active movement. It is the **passive movement** associated with **redistribution of tone** in different groups of related muscles.

■ BASIC PHENOMENA OF POSTURE

Basic phenomena for maintenance of posture are muscle tone and stretch reflex.

■ MUSCLE TONE

Definition

Muscle tone is defined as the state of continuous and passive partial contraction of muscle with certain vigor and tension. It is also called **tonus.** It is also defined as resistance offered by the muscle to stretch.

Significance of Muscle Tone

Muscle tone plays an important role in maintenance of posture. Change in muscle tone enables movement of different parts of the body. Muscle tone is present in all the skeletal muscles. However, tone is more in antigravity muscles such as extensors of lower limb, trunk muscles and neck muscles.

Development of Muscle Tone

Gamma motor neurons and muscle spindle are responsible for the development and maintenance of muscle tone.

Muscle tone is purely a reflex process. This reflex is a **spinal segmental reflex.** It is developed by continual synchronous discharge of motor impulses from the gamma motor neurons present in the anterior gray horn of the spinal cord (Figs. 157.1 and 157.2).

Sequence of events

1. Impulses from the gamma motor neurons cause contraction of end portions of intrafusal fibers (stimulus)
2. This stretches and activates the central portion of the intrafusal fibers, which initiates the reflex action for development of muscle tone by discharging the impulses
3. Impulses from the central portion of intrafusal fibers pass through primary sensory nerve fibers (afferent fibers) and reach the anterior gray horn of spinal cord
4. These impulses stimulate the alpha motor neurons in anterior gray horn (center)

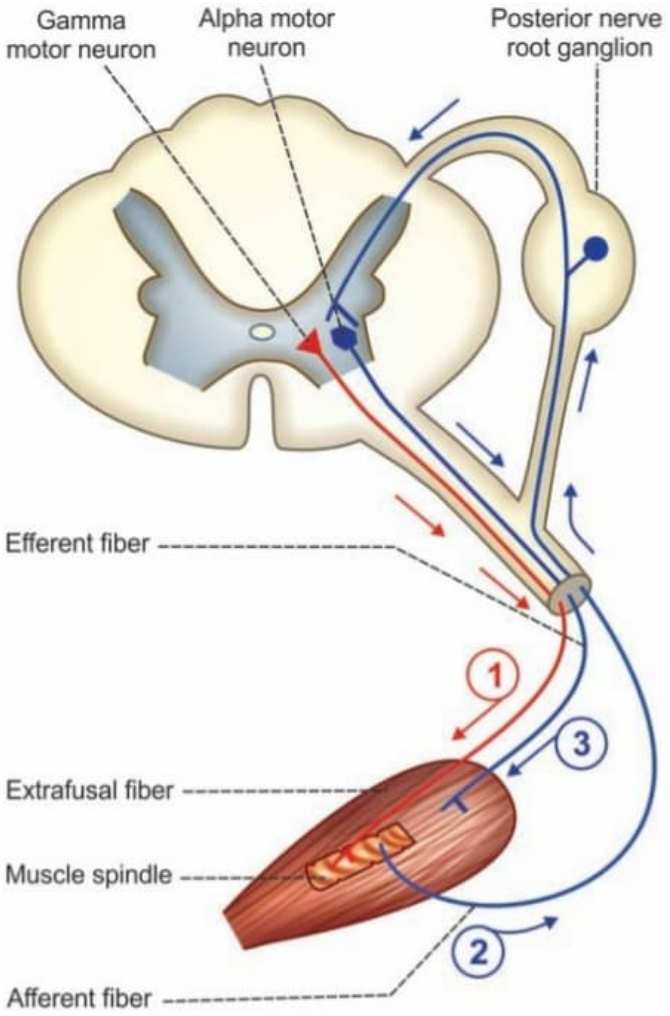

FIGURE 157.1: Development of muscle tone. 1. Impulses from γ-motor neuron stimulate muscle spindle. 2. Afferent impulses from muscle spindle to α-motor neuron. 3. Efferent impulses from α-motor neuron produce contraction of extrafusal fibers and develop muscle tone.

5. Alpha motor neurons in turn, send impulses to extrafusal fibers of the muscle through spinal nerve fibers (efferent fibers)
6. These impulses produce partial contraction of the muscle fibers resulting in development of muscle tone (response).

When the frequency of discharge from gamma motor neurons increases, the activity of muscle spindle is increased and muscle tone also increases.

Stimulation of gamma motor neurons increases the muscle tone. Lesion in gamma motor neurons leads to loss of tone in muscles.

Regulation of Muscle Tone

Though the muscle tone is developed by discharges from gamma motor neurons, it is maintained continuously

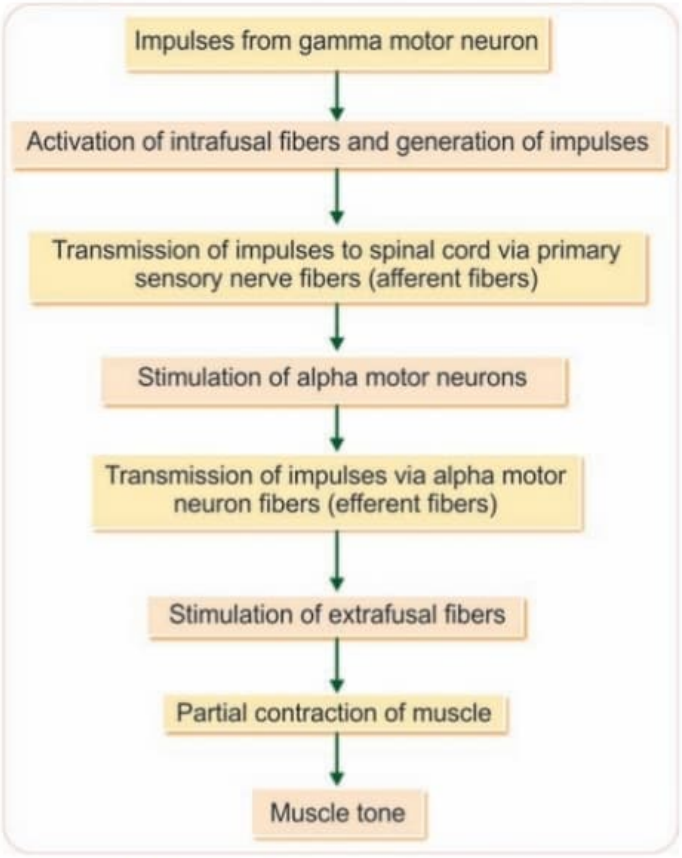

FIGURE 157.2: Schematic diagram showing development of muscle tone

and regulated by some supraspinal centers situated in different parts of brain. Some of these centers increase the muscle tone by sending **facilitatory impulses** while other centers decrease the muscle tone by **inhibitory impulses.**

Supraspinal facilitatory centers

Supraspinal centers, which increase the muscle tone:
1. Motor area 4 in cerebral cortex
2. Cerebellum
3. Descending facilitatory reticular system
4. Red nucleus
5. Vestibular nucleus.

Supraspinal inhibitory centers

Supraspinal centers, which decrease the muscle tone:
1. Suppressor areas of cerebral cortex
2. Basal ganglia
3. Descending inhibitory reticular system.

Role of motor area of cerebral cortex – coactivation

Motor area of cerebral cortex influences the activity of lower motor neurons by sending motor impulses through the pyramidal tract fibers. Motor impulses

from cerebral cortex stimulate both α-motor neurons and γ-motor neurons simultaneously. This type of simultaneous stimulation is called coactivation. It is also called **α-γ coactivation.** Stimulation of **α-motor** neurons causes contraction of **extrafusal fibers.** Stimulation of **γ-motor** neurons causes contraction of **intrafusal fibers,** which leads to increase in muscle tone.

Role of cerebellum and basal ganglia

It is interesting to find that cerebellum and basal ganglia influence the muscle tone without sending direct fibers to γ-motor neurons. These parts of brain influence the muscle tone indirectly through brainstem centers.

Role of brainstem centers

Brainstem centers which influence the γ-motor neurons are in reticular formation, red nucleus and vestibular nucleus. These centers modulate the discharge from γ-motor neurons by receiving signals from cerebral cortex, cerebellum and basal ganglia.

Abnormalities

Refer Chapter 34 for details of abnormalities of muscle tone.

■ STRETCH REFLEX

Basic reflex involved in maintenance of posture is the stretch reflex, which is described in detail in the previous chapter.

This reflex is normally present and serves particularly to maintain the body in an upright position. Such reflexes are, therefore more pronounced in extensor muscles.

■ POSTURAL REFLEXES

Postural reflexes are the reflexes which are responsible for maintenance of posture. Afferent impulses for the maintenance of posture arise from proprioceptors, vestibular apparatus and retina of eye and reach the centers in central nervous system (CNS). The centers, which maintain the posture, are located at different levels of CNS particularly cerebral cortex, cerebellum, brainstem and spinal cord. These centers send motor impulses to the different groups of skeletal muscles so that appropriate movements occur to maintain the posture.

■ CLASSIFICATION OF POSTURAL REFLEXES

Postural reflexes are generally classified into two groups:

A. Static reflexes
B. Statokinetic reflexes.

TABLE 157.1: Static postural reflexes

Reflex		Center	Animal preparation to demonstrate
General static reflexes (Righting reflexes)	1. Labyrinthine righting reflexes acting on the neck muscles	Red nucleus situated in midbrain	Thalamic or normal blindfolded animal
	2. Neck righting reflexes acting on the body		
	3. Body righting reflexes acting on the head		
	4. Body righting reflexes acting on the body		
	5. Optical righting reflexes	Occipital lobe	Labyrinthectomized animal
Local static reflexes	1. Positive supporting reflexes	Spinal cord	Decorticate animal
	2. Negative supporting reflexes		
Segmental static reflexes	Crossed extensor reflex	Spinal cord	Spinal animals
Statotonic or attitudinal reflexes	1. Tonic labyrinthine and neck reflexes acting on the limbs	Medulla oblongata	Decerebrate animal
	2. Labyrinthine and neck reflexes acting on the eyes		

■ STATOKINETIC REFLEXES

Statokinetic reflexes are the postural reflexes that maintain posture during movement. These reflexes are concerned with both angular **(rotatory)** and linear **(progressive)** movements. The vestibular apparatus is responsible for these reflexes. So, it is essential to study the structure and functions of vestibular apparatus to understand the statokinetic reflexes. The details of vestibular apparatus are described in Chapter 158.