

Exercise Therapy

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Stretch Reflex

Definition

The stretch reflex is also known as the myotatic reflex. It is a monosynaptic spinal reflex because the primary sensory neuron forms a direct excitatory synapse with the alpha motor neuron supplying the stretched muscle. The stretch reflex is an involuntary, automatic contraction of a muscle in response to its sudden stretching. It helps maintain muscle tone, regulate muscle length, and stabilize posture.

Receptors Involved

Muscle spindle: Detects muscle length and changes in muscle length.

Group Ia sensory afferent fibres: Primarily convey information about the dynamic component of stretch, including the rate of muscle lengthening.

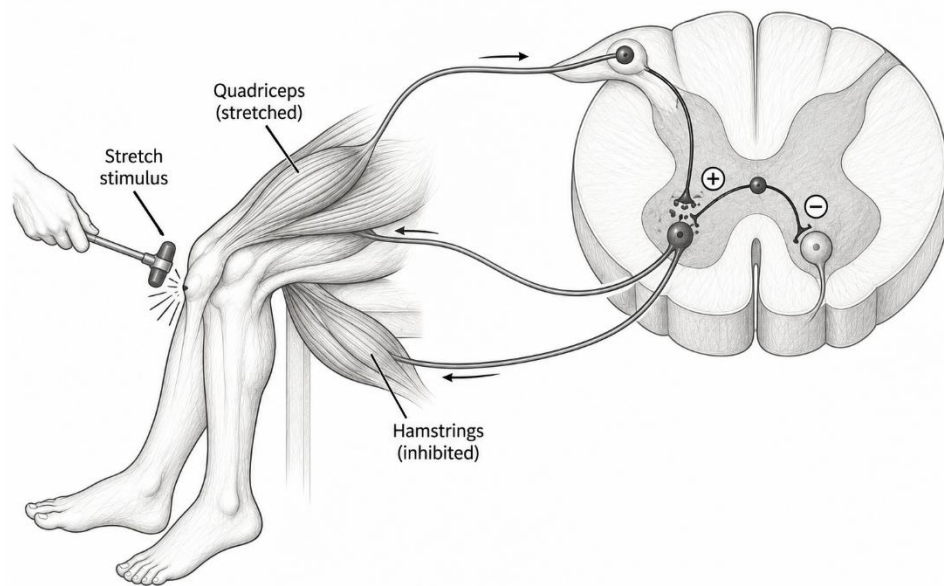
Group II sensory afferent fibres: Primarily convey information about sustained muscle length.

Alpha motor neurons: Supply extrafusal muscle fibres and produce muscle contraction.

Mechanism of the Stretch Reflex

The stretch reflex sequence:

1. Stretch stimulus: A muscle is suddenly stretched.
2. Activation of muscle spindles: The muscle spindle detects the change in muscle length.
3. Sensory impulse transmission: Group Ia sensory fibres carry impulses to the spinal cord through the dorsal root.
4. Synaptic transmission: The Ia sensory neuron forms an excitatory synapse directly with an alpha motor neuron in the spinal cord.
5. Motor impulse transmission: The alpha motor neuron carries impulses through the ventral root to the same muscle.
6. Muscle contraction: The stretched muscle contracts, opposing the initial stretch.
7. Reciprocal inhibition: Through an inhibitory interneuron, the antagonist muscle is inhibited, facilitating the movement produced by the agonist.
8. The direct sensory-to-motor pathway produces the monosynaptic component of the reflex, whereas reciprocal inhibition involves an additional interneuron.



Pathway of the Stretch Reflex

Stretch stimulus → Muscle spindle activation → Ia sensory afferent → Spinal cord → Alpha motor neuron → Neuromuscular junction → Contraction of the stretched muscle.

At the same time, inhibitory interneurons help reduce activity in the antagonist muscle.

Types of Stretch Reflex

Phasic Stretch Reflex: The phasic stretch reflex is a rapid, short-lasting muscle contraction in response to a sudden stretch. Eg: The knee-jerk reflex following a tap on the patellar tendon.

Tonic Stretch Reflex: The tonic stretch reflex refers to the sustained reflex activity associated with maintaining muscle length and muscle tone during prolonged or continuous stretch. Eg: Reflex contributions to the activity of postural muscles during standing.

Clinical Examples: Knee-Jerk Reflex, Ankle-Jerk Reflex

Functions of the Stretch Reflex

Maintenance of muscle tone: Helps maintain a baseline level of muscle activity.

Postural control: Contributes to the maintenance of upright posture.

Regulation of muscle length: Opposes sudden changes in muscle length.

Joint stability: Helps stabilize joints during unexpected disturbances.

Movement control: Contributes to the coordination of muscle activity during functional movements.

Protection against sudden lengthening: Helps resist rapid muscle stretch, although it is not an absolute protective mechanism.

Factors Affecting the Stretch Reflex

Rate of stretch: A rapid stretch generally produces a stronger dynamic response than a slow stretch of comparable magnitude.

Magnitude of stretch: Greater stretch may increase spindle activation, within physiological limits.

Muscle spindle sensitivity: Influenced by gamma motor neuron activity.

Descending control: Signals from higher centres modify spinal reflex excitability.

Muscle fatigue and physiological state: May alter the response.

Neurological conditions: Upper motor neuron lesions may increase tendon reflexes, whereas lesions affecting the reflex arc may reduce or abolish them.

Age and individual variation: Reflex responses can vary among individuals and across the lifespan.

Clinical Significance in Physiotherapy

- The stretch reflex is important in neurological examination and rehabilitation.
- Deep tendon reflex testing: Helps assess the integrity of the reflex arc and relevant spinal segments.
- Assessment of upper motor neuron lesions: Exaggerated tendon reflexes may occur in conditions involving reduced descending inhibition.
- Assessment of lower motor neuron lesions: Reduced or absent reflexes may occur when the sensory or motor components of the reflex arc are damaged.
- Spasticity assessment: Increased stretch-reflex excitability contributes to the velocity-dependent resistance to passive movement observed in spasticity.
- Rehabilitation planning: Understanding reflex activity helps physiotherapists select appropriate positioning, movement strategies, and interventions for patients with altered muscle tone.

References

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