

Exercise Therapy

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Neurophysiological Properties of Connective Tissue

Introduction

- The response of a muscle to stretching depends partly on the nervous system and sensory receptors present in the muscle-tendon unit.
- Two important sensory receptors are the muscle spindle and the Golgi tendon organ (GTO).
- These receptors detect changes in muscle length and tension and influence muscle activity during stretching.

Muscle Spindle

Definition: The muscle spindle is a sensory receptor located within skeletal muscles that detects changes in muscle length and the speed at which the muscle is stretched.

Location and structure: It consists of specialized muscle fibres called intrafusal fibres. Intrafusal fibres lie parallel to the ordinary muscle fibres, called extrafusal fibres. Gamma motor neurons regulate the sensitivity of the muscle spindle, while alpha motor neurons activate extrafusal muscle fibres.

Types of sensory nerve fibres: Type Ia (primary afferents): Detect changes in muscle length and the speed of stretching, Type II (secondary afferents): Mainly detect sustained changes in muscle length.

Function:

1. Detects muscle stretching.
2. Helps regulate muscle length and posture.
3. Protects against sudden changes in muscle length by contributing to the stretch reflex.

Stretch Reflex

Definition: The stretch reflex is an involuntary muscle contraction that occurs when a muscle is stretched.

Mechanism: A muscle is stretched, stimulating the muscle spindle, Sensory impulses travel to the spinal cord, Alpha motor neurons are activated, The stretched muscle contracts, increasing resistance to further lengthening.

Clinical significance: Rapid stretching can increase muscle activity and resistance to stretching. Therefore, slow and controlled stretching is generally preferred when the aim is to improve muscle extensibility.

Golgi Tendon Organ (GTO)

Definition: The Golgi tendon organ is a sensory receptor located in the tendon near the musculotendinous junction that detects changes in muscle-tendon tension.

Structure and nerve supply:

It consists of sensory nerve endings interwoven with collagen fibres in the tendon.

It transmits sensory information through type Ib afferent nerve fibres.

Function:

- Monitors tension produced during muscle contraction and passive stretching.
- Helps regulate muscle force during movement.
- Influences spinal motor activity to help control muscle tension.

Autogenic Inhibition

Definition: Autogenic inhibition is a reduction in the activity of a muscle's motor neurons associated with sensory input from that same muscle's Golgi tendon organs.

Mechanism: Tension develops in a muscle-tendon unit, The Golgi tendon organ detects the tension, Sensory impulses travel to the spinal cord, Spinal inhibitory pathways reduce alpha motor neuron activity to the same muscle, Muscle contraction may decrease, allowing the muscle to relax.

Clinical significance: This mechanism contributes to the regulation of muscle tension during stretching.

Reciprocal Inhibition

Definition: Reciprocal inhibition is the reduction in activity of one muscle when its opposing muscle (antagonist) is activated.

Example: During elbow flexion, activation of the biceps is accompanied by reduced neural activity in the triceps.

Clinical significance: Reciprocal inhibition can be used in stretching techniques such as contract-relax and agonist-contraction methods, although the precise effects depend on the technique used.

Neurophysiological Response of Muscle to Stretch

- Rapid stretching may activate muscle spindles and increase reflex muscle contraction, producing resistance to lengthening.
- Slow, controlled stretching generally reduces the likelihood of a strong stretch reflex compared with sudden stretching.
- Sustained stretching can influence muscle-tendon tension and sensory feedback.
- The Golgi tendon organ contributes to the regulation of muscle tension, but it does not simply switch the muscle off.

Improvements in flexibility are thought to result substantially from increased stretch tolerance and changes in the mechanical properties of muscle and surrounding connective tissues, rather than solely from reflex muscle inhibition.

Summary

- Muscle spindle: Detects muscle length and the velocity of length change; contributes to the stretch reflex.
- Golgi tendon organ: Detects muscle-tendon tension and helps regulate muscle force.
- Stretch reflex: Increases contraction of the stretched muscle in response to spindle activation.
- Autogenic inhibition: Neural inhibition associated with GTO input that can reduce activity in the same muscle.
- Reciprocal inhibition: Reduced activity in an opposing muscle when its antagonist is activated.
- Slow, controlled stretching: Helps limit rapid stretch-reflex activation and is commonly used to improve flexibility.

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