Overview of the Peripheral Nervous System and Reflex Mechanisms
Peripheral Nervous System

PNS main subdivisions

Somatic subdivision

Autonomic (ANS) subdivision
  - Sympathetic aspect
  - Parasympathetic aspect

Enteric nervous system
Outside of the brain and spinal cord

  Motor nerves

  Sensory nerves

  Ganglia

12 pairs of cranial nerves

31 pairs of spinal nerves

Autonomic nervous system = peripheral nerves that regulate automatic body functions
The PNS is responsible for transmitting messages from the sense organs (nose, ears, eyes) and sensory receptors in the soft tissue to the CNS and then relaying messages from the CNS back to the organs, glands, skeletal muscles, and joints to maintain homeostasis and perform functions to maintain life.
Practical Application

Stimulation of the peripheral nervous system and the responses elicited by this stimulation constitute one of the main physiologic ways massage and bodywork benefit the client. Therefore it is important to thoroughly understand the anatomy and physiology of the peripheral nervous system and the way soft tissue and movement methods interact with the peripheral nervous system.
Nerves

Sensory nerves
   Transmit input from sensory receptors
Motor nerves
   Innervate or provide action
Mixed nerves
   Contain sensory and motor fibers

*Afferent nerves carry information to the central nervous system, whereas efferent nerves carry impulses back to the body.*
A delicate connective tissue covering known as the endoneurium surrounds and holds each nerve fiber.

A group of nerve fibers is called a fasciculus, and each fascicle is surrounded by a sheath of connective tissue called the perineurium.

The entire nerve is surrounded by a connective tissue covering called the epineurium.
Cranial Nerves

Cranial nerves

Twelve pairs enter (sensor) or leave (motor) the olfactory bulbs, thalamus, visual cortex, and brainstem

Cranial nerves are identified by Roman numerals (order from front to back of brain) and names (refer to function or distribution).
Disorders of cranial nerves can arise from a stroke or tumor or from trauma.

A lack of function may indicate damage to a nerve associated with a certain function. For example, Bell’s palsy (paralysis of facial muscles) may be caused by injury to or inflammation of the seventh cranial nerve.
Cranial Nerves: Vagus Nerve

Practical Application

The distribution of the vagus nerve affects many visceral functions. Massage has been shown to support vagus nerve function, especially in premature babies, resulting in better development (particularly in weight gain) and fewer developmental problems.
Spinal Nerves

Spinal nerves

Thirty-one pairs originate in the spinal cord and emerge from the vertebral column.

*Spinal nerves are identified by a letter and number, which refer to their segment of attachment to the spinal cord.*
Cervical Plexus

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Innervation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ansa cervicalis</td>
<td>Hyoid muscles</td>
</tr>
<tr>
<td>Lesser occipital</td>
<td>Skin behind and above the ear</td>
</tr>
<tr>
<td>Greater auricular</td>
<td>Skin in front of, below, and over the ear and parotid glands</td>
</tr>
<tr>
<td>Transverse cervical</td>
<td>Skin on the anterior portion of the neck</td>
</tr>
<tr>
<td>Phrenic</td>
<td>Diaphragm</td>
</tr>
<tr>
<td>Supraclavicular</td>
<td>Skin on the shoulders and upper portion of the chest</td>
</tr>
<tr>
<td>Segmental branches</td>
<td>Deep neck muscles, midscalenes, and levator scapula muscle</td>
</tr>
</tbody>
</table>

**Diagram:**
- **Cervical plexus**
  - C1
  - C4
  - Hypoglossal nerve (XII)
  - Accessory nerve (XI)
  - Lesser occipital nerve
  - Nerve to sternocleidomastoid muscle
  - Greater auricular nerve
  - Transverse cervical nerve
  - Nerve to trapezius muscle
  - Supraclavicular nerves
  - Phrenic nerve
  - Ventral rami
Most of the spinal nerves converge in small groups to form an intersecting network; this network of nerves is a plexus.

The cervical plexus is made up of nerves C1 through C4 and part of C5.

Injury can cause loss of sensation and/or flaccid paralysis of the head, neck, and shoulders.

Nerve plexuses can be considered endangerment sites for deep sustained pressure during massage.
The brachial plexus is made up of nerves C5 through T1; it supplies the skin and muscles of the upper limbs.

<table>
<thead>
<tr>
<th>Nerve</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Dorsocapular</td>
<td>Superficial muscles of the scapula</td>
</tr>
<tr>
<td>Long thoracic</td>
<td>Serratus anterior muscle</td>
</tr>
<tr>
<td>Subclavian</td>
<td>Subclavius muscle</td>
</tr>
<tr>
<td>Suprascapular</td>
<td>Infraspinatus and supraspinatus muscles</td>
</tr>
<tr>
<td>Musculocutaneous</td>
<td>Biceps, brachialis, and coracobrachialis muscles; skin</td>
</tr>
<tr>
<td>Subscapular</td>
<td>Subscapularis and teres minor muscles</td>
</tr>
<tr>
<td>Median</td>
<td>Forearm flexors and palmar surface of the skin of the thumb, index, and middle fingers</td>
</tr>
<tr>
<td>Thoracodorsal</td>
<td>Latissimus dorsi muscle</td>
</tr>
<tr>
<td>Pectorals</td>
<td>Pectoralis major and minor muscles</td>
</tr>
<tr>
<td>Axillary</td>
<td>Deltoid and teres minor muscles and skin</td>
</tr>
<tr>
<td>Radial</td>
<td>Triceps and forearm extensors, skin of the forearm and hand, and dorsal surface of the thumb, index, and middle fingers</td>
</tr>
<tr>
<td>Medial cutaneous</td>
<td>Skin of the arm</td>
</tr>
<tr>
<td>Ulnar</td>
<td>Muscles of the hand and skin of the ring and pinkie fingers</td>
</tr>
</tbody>
</table>
Lumbosacral Plexus

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Innervation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iliohypogastric</td>
<td>Abdominal muscles and skin of the abdomen and buttocks</td>
</tr>
<tr>
<td>Ilioinguinal</td>
<td>Abdominal muscles and skin of the external genitalia</td>
</tr>
<tr>
<td>Genitofemoral</td>
<td>Skin of the external genitalia and inguinal region</td>
</tr>
<tr>
<td>Lateral femoral</td>
<td>Skin of the thigh (except the medial cutaneous portion)</td>
</tr>
<tr>
<td>Femoral</td>
<td>Hip flexors and extensors and skin of the medial and anterior thigh and medial leg and foot</td>
</tr>
<tr>
<td>Obturator</td>
<td>Adductor muscles and skin of the medial thigh</td>
</tr>
<tr>
<td>Sacral plexus</td>
<td>Created from nerves L5 to S3</td>
</tr>
<tr>
<td>Sciatic</td>
<td>Leg and foot muscles; the skin of the foot, which divides into the tibial and peroneal nerves at the popliteal fossa</td>
</tr>
<tr>
<td>Gluteal</td>
<td>Buttocks and tensor fasciae latae muscle</td>
</tr>
<tr>
<td>Nerves to hip</td>
<td>Piriformis, quadratus femoris, rotators, obturator internus, and superior and inferior gemellus</td>
</tr>
<tr>
<td>Posterior femoral</td>
<td>Skin of the buttocks, perineum, back, cutaneous of the thigh, and leg</td>
</tr>
<tr>
<td>Pudendal</td>
<td>Muscles and skin of the perineum (may be considered in the coccygeal plexus)</td>
</tr>
</tbody>
</table>
The lumbosacral plexus is made up of the lumbar plexus and the sacral plexus.

The sciatic nerve supplies the lower body.

Injury to this plexus can cause loss of sensation and/or flaccid paralysis of the abdomen and lower extremities.
Dermatomes

Sections of skin supplied by a single nerve
Match up with pathways of Chinese meridians

Although this diagram doesn’t show it, many of the nerve supplies to adjacent dermatomes overlap.
Myotomes indicate the relationship between the spinal nerve and the muscles innervated by it.

A skeletal muscle or group of muscles that receives motor axons from a single spinal nerve is known as a myotome.

As with dermatomes, the boundaries of myotomes are not always exact.
Reflex Mechanisms

Nerve reflex: involuntary action

Two types:

Simple or unconditioned or natural
  No thinking or reasoning
Complex or conditioned
  Conditioned response
  Fast response time
  Allow body to prevent injury
In the simple, unconditioned, or natural type of reflex, the brain is not directly involved. The processing occurs in the spinal cord. An example of a simple reflex is blinking the eyes in the presence of a strong light.

The complex, or conditioned, reflex involves the brain, but it is also as fast as the simple reflex. Salivation while smelling a favorite food is an example of a conditioned reflex.
Reflex Patterns

Somatosomatic: stimulus on the skin, tendons, or joints that produces a reflex on a related somatic structure

Somatovisceral: somatic stimulation results in reflex in a visceral structure.

Viscerosomatic: localized visceral stimulus produces a somatic response.

Viscerovisceral: visceral stimulus produces visceral response.
Sensory Receptors

A

Free nerve endings
Merkel endings (Merkel's disk)
Krause's end bulb
Meissner's corpuscle
Pacinian corpuscle
Hair root plexus

B

Type IB sensory fiber
Type II sensory ending
Type IA sensory endings
α Efferent motor fiber
δ Efferent motor fiber

Tendon
Capsule
Perimysium of muscle fiber bundle
Connective tissue capsule
Muscle fibers (extrafusal fibers)

Intrafusal fibers
Nuclear bag fibers
Nuclear chain fibers
Neuromuscular spindle (muscle spindles)
Exteroceptors are on or near the body’s surface and are sometimes called cutaneous receptors. Visceroceptors (interoceptors) are located internally, often within body organs, or viscera. Proprioceptors are a specialized type of viscerocceptor in muscles, joints, and tendons.

Thermal receptors (free nerve endings) specifically detect temperature, whereas mechanical receptors can identify touch and pressure, among other things. Thermal receptors are a subcategory of mechanical receptors.
Reflex Arc

Stretch reflex
Tendon reflex
Flexor reflex
Crossed extensor reflex
Proprioception
Gamma motor neuron discharge
Fascial innervations
Stretch reflex: protective contraction when a muscle is stretched suddenly or intensely.

The tendon reflex is also known as the inverse stretch reflex.

The flexor reflex causes all the right muscles in an endangered limb to contract in order to withdraw the limb.

These mechanisms play a role in how the body processes mechanical forces imposed on the body during massage, as well as various muscle energy methods and stretches.
The Autonomic Nervous System, the Five Senses, and Pathologic Conditions of the Peripheral Nervous System
The sympathetic nervous system stimulates. It usually functions when the body is under stress.
The parasympathetic nervous system tends to diminish or inhibit actions.

It works under normal body conditions to conserve energy.

Massage modalities initially stimulate sympathetic functions. Homeostatic mechanisms then work to increase restorative parasympathetic functions as needed.
Structure and Function

Sympathetic
- Begins in spinal cord
- Major function: emergency response
- Responds whether threat is real or imagined

Parasympathetic
- Cranial nerves to organs
- Energy conservation system
- Regulates digestion, slows heart rate
Reactions to parasympathetic stimulation are highly localized and tend to counteract some of the effects of the sympathetic nervous system.

Massage therapists elicit a parasympathetic response by Point holding methods, such as acupressure, reflexology, and acupuncture, cause a release of endorphins that stimulate the parasympathetic responses of relaxation and contentment.
Eastern/Western Connection

ANS is an example of yin/yang concept.

Correlation between sympathetic ANS function and organ points in Asian meridian system

Overlap between acupuncture points and meridians to fascial planes of body

The effects of many neurotransmitters may validate the use of sensory stimulation methods, such as acupressure, reflexology, and acupuncture, to treat pain and anxiety.
Five Basic Senses

- Touch
- Hearing
- Vision
- Taste
- Smell

More than 20 senses have been identified; these five are the most basic.
Touch

The areas of the body that have more nerve endings are more sensitive.

Tongue, lips, thumb, and fingers have the most touch sensitivity.

Four touch sensations

- Cold
- Heat
- Contact
- Pain

The sense of touch occurs in the body as nerve endings in the skin called sensory receptors transmit sensations to the brain.
Hearing

Sounds are vibrations turned into recognizable patterns.

Hearing is well-developed—even at birth!

Vibrations taken in by external ear

- Funneled into middle ear, eardrum
- Eardrum vibrates, pulls tiny bones

Sensory information transformed into electrical signals, then conducted to the brain
If our sense of hearing is well-developed at birth, how about in the womb? Does a fetus respond to sound? (Recent research has shown this to be the case. Sound carries reasonably well through amniotic fluid.)

The stirrup bone inside the ear is the smallest bone in the body.
Structures of the Ear

The vestibular system helps us maintain our balance.

Only the inner ear functions in the vestibular system.
The cerebral cortex interestingly, signals from the right and left eye stay separate until the brain sorts them out.

Iridology is the science that specializes in relations between disease and the shape, color, and other individual characteristics of the iris.
Taste

One of the more complex senses
Connected to smell
Average adult has more than ten thousand taste buds.
Culture and genetics determine preferences for certain kinds of food.

The four taste areas on the tongue are sweet, salty, sour, and bitter. All other taste sensations come from smell.

TCM doctors use the tongue for diagnosis.
Smell

A.

Olfactory bulb
Olfactory receptors
Turbinates:
Superior
Middle
Inferior
Vestibule

B.

Root
Dorsum
Tip
Ala
Base

C.

Superior turbinate
Middle turbinate
Inferior turbinate

Superior meatus
Middle meatus
Inferior meatus
When an odor makes contact with the chemical receptors in the roof of the nasal cavity, those receptors transform the odor into chemical signals to be transported to the brain.

TCM doctors will “smell” a patient’s body odors and breath for diagnosis—a lot of information can be determined with this sense.
Medications and the Autonomic Nervous System

Alpha-adrenergic blockers
Beta-adrenergic medications
Beta-adrenergic blockers
Parasympathetic blockers

*Adrenergic is an adjective that describes anything activated by epinephrine or an epinephrine-like substance.*
Pathologic Conditions

Compression syndromes
Nerve root compression
Disk herniation
Massage considerations:
- If combined with other methods, surgery may not be necessary.
- If surgery performed, obtain physician clearance.
- Work close to surgical area can begin after stitches have been removed and all inflammation abates.
- 8-12 weeks before direct work on a new scar
Compression syndromes, entrapment neuropathies, and nerve impingement (pinched nerve) are disorders of the peripheral nerves characterized by pain or loss of function (motor, sensory, or both) of the nerves as a result of chronic compression. “Pinched” nerves are most common.

Carpal tunnel syndrome is the compression of the median nerve as it passes under the transverse carpal ligament at the palmar aspect of the wrist. It can be caused by anything that results in swelling of the hand or wrist, such as repetitive motion injury or fluid, especially in postmenopausal women.
Pathologic Conditions

Viral infections
- Bell’s palsy
- Guillain-Barré syndrome
- Herpes
- Polio

Massage considerations:
- Can be supportive and reduce stress
- Follow Standard Precautions
- Must gauge intensity and duration closely
- Beneficial for postacute polio syndrome
The less-is-more philosophy of intervention, which calls for shorter, more frequent interventions, often is indicated.

Massage is beneficial for postacute polio syndrome but only under a doctor’s supervision.
Multiple or unknown causes

- Multiple sclerosis
- Myasthenia gravis

Massage considerations:

- Effective part of a comprehensive, long-term care program
- Must gauge intensity and duration closely

"Massage and other forms of bodywork can help manage secondary muscle tension caused by the alteration of posture and the use of equipment, such as wheelchairs, braces, and crutches."
Neurotransmitter-based disorders

Depression and anxiety states
Massage and exercise can play important part in treatment.

Neuropathy
Massage may provide short-term, symptomatic pain relief.

Headache
Massage indicated in chronic headache conditions

Vertigo
Massage and other forms of soft-tissue therapy are effective in treating muscle tension headaches.

Movement therapies can help or aggravate vertigo; therefore, the practitioner must take care to design an individual therapeutic program based on the client’s history.
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