

# "Autonomic Nervous System in Head and Neck"

## » Cervical Plexus

- Formed by anterior rami of first four cervical nerves (C1-C4).
- Rami join via connecting branches, forming loops.
- Loops lie in front of origins of levator scapulae and scalenus medius muscles.
- Prevertebral layer of deep cervical fascia covers the plexus anteriorly.
- Related to internal jugular vein within the carotid sheath.
- Supplies skin and muscles of the head, neck, and shoulder, plus diaphragm and other thoracic structures.

## > Cutaneous Branches

- Four cutaneous nerves:
  - Lesser occipital
  - Great auricular
  - Transverse cervical
  - Supraclavicular
- Supply skin over lower head, and front and sides of neck.
- Emerge from a common point (nerve point of the neck):
  - Located at posterior margin of sternocleidomastoid, at about its midpoint.
  - Distribute from this point.

## > Specific Cutaneous Nerves

- Lesser occipital nerve (C2):
  - Supplies back of scalp and auricle.
- Great auricular nerve (C2, C3):
  - Supplies skin over angle of mandible.

- Transverse cervical nerve (C2, C3):
  - Supplies skin over front of neck.
- Supraclavicular nerves (C3, C4):
  - Have medial, intermediate, and lateral branches.
  - Supply skin over shoulder region.
- Clinical note: Pain may be referred along these nerves from the phrenic nerve (e.g., gallbladder disease).

#### > Muscular Branches (Neck)

- Nerve branches supply:
  - Prevertebral muscles
  - Sternocleidomastoid
  - Levator scapulae
  - Trapezius

- Branches to:
  - Sternocleidomastoid (C2, C3) – proprioceptive
  - Trapezius (C3, C4) – proprioceptive
- Branch from C1 joins the hypoglossal nerve:
  - Some C1 fibers leave as descending branch.
  - Descending branch unites with descending cervical nerve (C2, C3) to form ansa cervicalis.
- Ansa cervicalis supplies:
  - Omohyoid
  - Sternohyoid
  - Sternothyroid
- Other C1 fibers within the hypoglossal leave as:
  - Nerve to thyrohyoid
  - Nerve to geniohyoid

## » Phrenic Nerve

- Arises from C3, C4, and C5 of the cervical plexus.
- Runs vertically downward across front of scalenus anterior.
- Enters thorax by passing in front of subclavian artery.

### > Functions of the Phrenic Nerve

- Only motor nerve to the diaphragm.
- Carries sensory branches from:
  - Pericardium
  - Mediastinal parietal pleura
  - Pleura and peritoneum covering upper and lower surfaces of central diaphragm

## » Summary Table

BRANCHES	DISTRIBUTION
Cutaneous	
Lesser occipital	Skin of the scalp behind the ear
Great auricular	Skin over the parotid salivary gland, auricle, and angle of jaw
Transverse cervical	Skin over side and front of the neck
Supraclavicular	Skin over the upper part of the chest and shoulder
Muscular	
Segmental branches	Prevertebral muscles, levator scapulae
Ansa cervicalis (C1, 2, 3)	Omohyoid, sternohyoid, sternothyroid
C1 fibers via the hypoglossal nerve	Thyrohyoid, geniohyoid
Phrenic nerve (C3, 4, 5)	Diaphragm
Sensory phrenic nerve (C3, 4, 5)	Pericardium, mediastinal parietal pleura, and pleura and peritoneum covering the central diaphragm

## » Autonomic Nervous System (Cranio cervical Region)

### > Overview

- Consists of sympathetic and parasympathetic components.
- Sympathetic part:
  - Has a comparatively simple organizational scheme.
- Parasympathetic part:
  - Has more components and more complex pathways.

### i) Sympathetic Part

#### > Preganglionic Neurons

- Originate in lateral horn of first through fourth spinal cord segments.
- Axons enter sympathetic trunk at those levels via white rami communicantes.

- Axons ascend through the sympathetic trunk.

## » Cervical Part of Sympathetic Trunk

- Extends from base of skull to neck of first rib.
- Becomes continuous with thoracic part of sympathetic trunk.
- Lies directly behind internal and common carotid arteries:
  - Positioned medial to the vagus nerve.
- Embedded in deep fascia:
  - Located between the carotid sheath and the prevertebral layer of deep fascia

## » Cervical Ganglia

- The sympathetic trunk possesses three ganglia:
  - Superior cervical ganglion
  - Middle cervical ganglion
  - Inferior cervical ganglion

- Most preganglionic fibers synapse in the cervical ganglia.
- Postganglionic fibers distribute from the ganglia.

## » Superior Cervical Ganglion

### > Location and Structure

- Lies immediately below the skull.
- Is the cranial end of the sympathetic trunk.
- Largest of the sympathetic chain ganglia.
- Formed from embryonic C1 to C4 sympathetic ganglia primordia.
- Located at the level of the second cervical vertebra.
- Embedded in deep fascia:
  - Between the carotid sheath and prevertebral fascia.
  - Lies over the longus capitis muscle.

## > Function

- All sympathetic fibers in the head are postganglionic fibers.
- These fibers branch off the superior cervical ganglion.

## » Branches of the Cervical Sympathetic Chain

### 1) Vascular Branches

#### > General Features

- Arterial branches go to:
  - Common carotid artery
  - External carotid artery
  - Vertebral artery
- Form arterial plexuses around these arteries:
  - Carotid plexus
  - Vertebral plexus
- Distribute sympathetic fibers along the branches of the arteries.

## > Internal Carotid Plexus

- Internal carotid nerve:

- Accompanies internal carotid artery into the carotid canal (temporal bone).
- Forms a plexus around the artery: → Internal carotid plexus.

## > Branches of internal carotid plexus:

- Caroticotympanic nerve:

- Joins the tympanic plexus in the middle ear.

- Deep petrosal nerve:

- Joins greater petrosal nerve → forms nerve of the pterygoid canal.

- Sympathetic root of the ciliary ganglion:

- Arises from internal carotid plexus → connects with ciliary ganglion in orbit.

## 2) Cranial Nerve Branches

- Sympathetic fibers join cranial nerves:
  - Oculomotor (CN III)
  - Trochlear (CN IV)
  - Trigeminal (CN V)
  - Abducens (CN VI)
  - Facial (CN VII)
  - Glossopharyngeal (CN IX)
  - Vagus (CN X)
  - Hypoglossal (CN XII)

## 3) Gray Rami Communicantes

- Supply anterior rami of:
  - C1 to C4 spinal nerves

## 4) Pharyngeal Branches

- Unite with:
  - Pharyngeal branches of glossopharyngeal (CN IX) and vagus (CN X)
- Form the pharyngeal plexus

## 5) Superior Cardiac Nerve

- Descends in the neck
- Ends in the cardiac plexus in the thorax

## » Middle Cervical Ganglion

### > Location

- At the level of the cricoid cartilage

### > Branches

- Gray rami communicantes to:
  - C5 and C6 anterior rami
- Thyroid branches:
  - Travel along inferior thyroid artery → thyroid gland
- Middle cardiac nerve:
  - Descends in the neck → ends in cardiac plexus

## » Inferior Cervical Ganglion / Stellate Ganglion

### > Structure

- Often fused with first thoracic ganglion → forms stellate ganglion

### • Location:

- Between transverse process of C7 and neck of 1st rib
- Behind vertebral artery

### > Connecting Bundles

- Connects to middle cervical ganglion via two or more nerve bundles
- Most anterior bundle:
  - Crosses in front of 1st part of subclavian artery
  - Then turns upward behind it
  - Called ansa subclavia

## > Branches

- Gray rami communicantes to:

- C7 and C8 anterior rami

- Arterial branches:

- To subclavian artery

- To vertebral artery

- Inferior cardiac nerve:

- Descends → joins cardiac plexus in thorax

## ii) Parasympathetic Part (Cranial Outflow)

### » Preganglionic Neurons: Origins

- Located in brainstem nuclei of CN III, VII, IX, X:

- Oculomotor nerve (CN III) → Edinger-Westphal nucleus

- Facial nerve (CN VII) → Lacrimal and Superior Salivatory nuclei

- Glossopharyngeal nerve (CN IX) → Inferior Salivatory nucleus

- Vagus nerve (CN X) → Dorsal nucleus of vagus
- Fibers are myelinated preganglionic axons.
- Exit brainstem within their respective cranial nerves.

## » Synapse Sites: Parasympathetic Ganglia

- Peripheral ganglia (close to target organs):
  - Ciliary ganglion
  - Pterygopalatine ganglion
  - Submandibular ganglion
  - Otic ganglion

## » Cranial Nerve Pathways

### 1) Oculomotor Nerve (CN III)

- Preganglionic fibers → Ciliary ganglion (in orbit)
- Postganglionic fibers:
  - Via short ciliary nerves

- Target:

- Sphincter pupillae → Pupillary light reflex
  - Ciliary muscle → Accommodation

## 2) Facial Nerve (CN VII)

### a) Pterygopalatine Pathway

- Preganglionic fibers via Greater petrosal nerve
- Synapse in Pterygopalatine ganglion (in pterygopalatine fossa)
- Postganglionic fibers:
  - Via branches of maxillary and ophthalmic nerves
- Target:
  - Lacrimal gland (→ lacrimation)
  - Nasal glands

## b) Submandibular Pathway

- Preganglionic fibers via Chorda tympani nerve:
  - Passes through middle ear
  - Joins lingual nerve (branch of mandibular nerve)
- Synapse in Submandibular ganglion
  - Postganglionic fibers:
    - > Target:
      - Submandibular gland
      - Sublingual gland
      - Glands in oral floor

## 3) Glossopharyngeal Nerve (CN IX)

- Preganglionic fibers via:
  - Tympanic branch
  - Lesser petrosal nerve
- Synapse in Otic ganglion (in infratemporal fossa)

- Postganglionic fibers:
  - Join auriculotemporal nerve (from mandibular nerve)
- Target:
  - Parotid salivary gland
- 4) Vagus Nerve (CN X)
  - No cranial ganglion involvement
  - Preganglionic fibers extend to postcranial plexuses:
    - Cardiac plexus
    - Pulmonary plexus
    - Myenteric (Auerbach) plexus
    - Mucosal (Meissner) plexus
  - Postganglionic fibers:
    - Are unmyelinated and short
    - Innervate: Neck, thoracic and abdominal viscera

## "Clinical Notes"

### » Phrenic Nerve Injury & Diaphragm Paralysis

- Phrenic nerve:

- Sole motor supply to diaphragm
- Each nerve supplies ipsilateral half

- Injury (e.g., penetrating neck wounds):

- > Paralysis of corresponding half
- > Diaphragm becomes elevated into thorax (due to positive abdominal pressure)
- > May cause collapse of lower lobe of ipsilateral lung

- Accessory phrenic nerve:

- Present in ~1/3 of individuals
- May arise from C5 root, travel with nerve to subclavius, and join phrenic trunk in thorax

## » Sympathectomy for Upper Limb Arterial Insufficiency

- Preganglionic fibers:

- From T2-T8 spinal cord levels
- Enter sympathetic trunk via white rami

- Ascend and synapse in:

- T2 ganglion
- Stellate ganglion (fusion of inferior cervical & first thoracic)
- Middle cervical ganglion

- Postganglionic fibers:

- Exit via gray rami
- Join roots of brachial plexus

- Upper limb sympathectomy:

- Removes T2 & stellate ganglia → blocks sympathetic supply to arm

- Stellate ganglion removal complications:

→ Loss of sympathetic supply to head & neck

- Effects:

- Vasodilation of facial vessels
    - Anhidrosis
    - Nasal congestion
  - May cause Horner syndrome
- Therefore: Stellate ganglion usually spared during upper limb sympathectomy

## » Horner Syndrome

- Features:

- > Miosis (pupil constriction)
  - > Ptosis (drooping upper eyelid)
  - > Anhidrosis (loss of sweating)
  - > Facial vasodilation
  - > +/- Enophthalmos (eye retraction — possibly apparent)
- Cause: Interruption of sympathetic pathway to head

- Pathologic causes:

- Brainstem/cervical spinal cord lesions
  - Cervical sympathetic trunk injury
- Traction on stellate ganglion (e.g., cervical rib)
  - Malignancy affecting ganglion

## » Stellate Ganglion Block

- Purpose: To block sympathetic output for clinical relief

- Landmark:

- Carotid tubercle (anterior tubercle of C6 transverse process) — ~1 fingerbreadth lateral to cricoid cartilage

- Procedure:

- Displace carotid sheath & sternocleidomastoid laterally
- Insert needle over C6 tubercle
- Inject local anesthetic beneath prevertebral fascia

- Effect: Temporary block of stellate ganglion + rami communicantes