Cranial nerves: Nuclei, Distribution & Lesions

Amadi O. Ihunwo, PhD
School of Anatomical Sciences
Outline for Each Cranial Nerve

- Origin & point of attachment in brainstem
- Course – Any significance!!!
- Point of exit from or entry into skull (Foramen)
- Distribution/Function (Motor, parasympathetic, sensory, special sensation)
- Dysfunction in case of lesion
Cranial Nerves in Humans

12 bilaterally paired nerves attached directly to a part of brain: cerebrum (I & II); midbrain (III, IV) pons (V, VI, VII, VIII) medulla (IX, X, XI, XII)
Topographic Position of Cranial nerve nuclei

Motor & Parasympathetic

Sensory

III
IV
V
VI
VII
Superior Salivatory (VII)
Inferior Salivatory (IX)
Nuc Ambiguus (X,XI)
Dorsal Nuc X

XII

Mesencephalic
Pontine
Spinal tract of V (V,IX)
Vestibular
Cochlear

Nuc
Tractus Solitarius
VII, IX, X
Olfactory Nerve (I)

- **Origin**: 20 neurons from mucosa of upper part of nasal cavity: Pass via **cribriform foramina**
- **End**: Olfactory bulb (largest neuron called mitral cell)
- Olfactory tracts from bulb divide into lateral & medial striae
- **Lateral stria** → lateral olfactory area of cerebral cortex
- **Medial stria** → opposite olfactory bulb via anterior commissure
CN I Olfactory: Function & applied

- **Function**: smell

- **Dysfunction**: Anosmia – loss of olfaction

- **Applied**
  - Head injury may tear nerves filaments passing through cribriform plate especially in fractures involving anterior cranial fossa
  - Leakage of CSF through nose (CSF rhinorrhoea) from tearing of meningeal covering of nerve
Optic Nerve (II)

- **Origin:** Axons of ganglionic cells of retina
- **Course:**
  - Pass through **optic canal.** Unites with that of opposite side to form **optic chiasma**
  - Continues as **optic tract** & end in Lateral Geniculate Body (LGB)
  - Optic (geniculo-calcarine) radiations arise from LGB & end in visual cortex
- **Function:**
  - Vision & accommodation reflexes
Oculomotor Nerve (III)

**Origin:** Oculomotor Nucleus (Motor) & Edinger-Westphal (Parasympathetic)

- **Course:** Lies on medial side of crus cerebri, along lateral wall of cavernous sinus; enter orbit through **superior orbital fissure**. Divides into **superior & inferior divisions**
- Parasympathetic fibres pass via inferior division

Cranial nerves III, IV, & VI
Oculomotor Nerve...

**Distribution:** Extraocular muscles

- Superior, inferior, medial recti, inferior oblique, levator palpebral superioris
- Sphincter pupillae muscle of iris & ciliary muscle constricts pupil & accommodates lens

**Dysfunction**

- Eye deviation - down & out (Lateral stabismus)
  - lateral rectus & superior oblique unopposed.
- Ptosis (drooping of eyelid)
- Mydriasis (fully dilated pupil)
- Loss of power of accommodation
- Diplopia
Trochlear Nerve (IV)

- **Origin**: Trochlear Nucleus. Most slender of cranial nerves
- **Course**: Only nerve to emerge from dorsal part of brainstem & its fibres cross. Passes onto lateral wall of cavernous sinus, then **superior orbital fissure**
- **Distribution**: Superior oblique
- **Dysfunction**: Rarely paralysed alone
  - Diplopia (double vision) on looking down & Extorsion
Abducens Nerve...

- **Origin**: Abducens nucleus
- **Course**: Longest course in subarachnoid space.
- Emerges between pons & medulla, passes through cavernous sinus
- Enters orbit through **superior orbital fissure**
- **Distribution**: Supplies Lateral rectus
- **Dysfunction**: Medial deviation & diplopia. Cannot look outwards
Trigeminal Nerve...

Largest CN

**Origin:**
- Motor Nucleus
- Sensory Nucleus:
  - mesencephalic Nuc.
  - pontine (chief) & spinal Nuc

**Has 3 divisions:**
- Ophthalmic
- Maxillary
- Mandibular

Ophthalmic Division (V1) - **superior orbital fissure**
Maxillary Division (V2) - **foramen rotundum**
Mandibular Division (V3) - **foramen ovale**
Ophthalmic Nerve [V1]

Branches: Recurrent meningeal, Frontal, lacrimal, nasociliary (ant. & post. ethmoidal), (long & short ciliary, infratrochlear)
Maxillary nerve [V2]

**Branches:** meningeal, Zygomatic (facial & temporal)
- Post superior alveolar (psa), posterior superior lateral nasal (psln), Infraorbital, Greater & lesser palatine
- Nasopalatine, Pharyngeal
Mandibular nerve [V3]

Branches:
Meningeal, Buccal, Auriculotemporal (AT)
Inferior alveolar, lingual (L), muscles of mastication (M, LP), Tensor veli palatini, Mylohyoid, anterior belly of digastric, tensor tympani
Summary Distribution/dysfunction of V

- **Sensory**
  - Periodontal ligaments of teeth
  - Reflex control of force of bite
  - Discriminative tactile: from skin of face, mucous membrane of middle ear, pharygotympanic tube, pharynx, larynx

- **Motor**
  - Muscles of mastication
  - Tensor tympani
  - Tensor veli palatine
  - Mylohyoid
  - Anterior belly of digastric

- **Trigeminal Nerve dysfunction**
  - Trigeminal neuralgia – pain in distribution of maxillary and/or mandibular nerve.
  - Decreased forehead pain and touch, corneal reflex (1st sign of lesion of ophthalmic nerve), cheek touch & pain, jaw touch & pain & jerk, and weakness of muscles of mastication
Cranial Nerves in Base of Skull

II

V

VII & VIII

IX, X, XI

III

IV

VI

XII
Facial Nerve: Origin and Course

• **Origin:**
  - Motor Nucleus: Fibres loop over CN VI nucleus creating facial colliculus in floor of 4\textsuperscript{th} ventricle (internal genu)
  - Superior salivatory & Lacrimal Nucleus (parasympathetic)
  - Sensory Nucleus (Tractus solitarius/Gustatory Nucleus)

• **Course:** *Internal acoustic meatus to enter facial canal*
  - Forms geniculate ganglion (taste & salivation) and turns sharply inferiorly (*chorda tympani* leaves)
  - Stylomastoid foramen to supply muscles including those of facial expression.
CN VII Distribution

- Motor to
  - muscles of facial expression (TZBMC), stapedius, stylohyoid, posterior belly of digastric
- Taste from anterior 2/3 of tongue
- Skin of external acoustic meatus
- Mucous membrane of nasopharynx & palate
- Lacrimal, nasal, palatine, submandibular & sublingual glands.
CN VII Dysfunction

- Most frequently paralysed of all cranial nerves
- Infranuclear lesion (LMN) – Bell’s palsy (most common):
  - facial muscles paralysis/weakness with asymmetry of corner of mouth
  - Inability to close eye or wrinkle forehead on affected side
  - excessive acuteness of hearing (hyperacusis)
- Decreased tearing, salivation & taste
Vestibulo-cochlear Nerve

- **Origin/termination:**
  - Vestibular ganglion (semicircular canal) & end in Vestibular Nucleus
  - Spiral ganglion (Organ of Corti) & end in Cochlear Nucleus
- Both pass with CN VII through **internal acoustic meatus**

- **Functions:**
  - Semicircular canals, utricle & saccule (balance and posture).
  - Cochlea (hearing)
- **Dysfunction**
  - Vestibular nerve: Dysequilibrium & vertigo
  - Decreased hearing (nerve deafness) – cochlear lesion
  - Conduction deafness – external or middle ear
Glossopharyngeal (IX)

- **Origin:** Nuc. ambiguus (Motor)
  - Inferior salivatory (Parasympathetic)
  - Tractus solitarius (Special sensory)
  - Spinal Nuc. of V (General sensory)

- **Course:** Passes through **jugular foramen**

- **Distribution:** Stylopharyngeus, Parotid gland (parasympathetic & sensation), carotid body & sinus, pharynx & middle ear, Taste posterior 2/3 of tongue, Tonsil & palate, Sensation from external ear

- **Dysfunction:** Decreased Salivation, sensation to back of ear, gag reflex (closure of glottis), taste

- Paralysis of stylopharyngeus is insignificant
Vagus Nerve (X)

• ‘Wanderer’; longest course & largest distribution

• **Origin**: Nuc ambiguus (Motor); Dorsal Nucleus of X (Parasympathetic) & Tractus solitarius (Sensory)

• **Course**: Leaves skull through *jugular foramen*, passes within *carotid sheath* in neck then *Oesophageal opening* to supply abdominopelvic organs via coeliac, hepatic, renal & hypogastric plexuses
Distribution/Dysfunction of Vagus Nerve

- **Motor:** Pharyngeal constrictor muscles, intrinsic muscles of larynx, muscles of palate.
- **Parasympathetic:** Smooth muscles of trachea, bronchi, GI tract, heart
- **Sensory:** Tongue, pharynx, larynx, thoraco-abdominal viscera, auricle, external auditory meatus, meninges of post cranial fossa.

- **Dysfunction:**
  - Recurrent laryngeal nerve palsies are common from malignant diseases & surgical damage during surgery on thyroid gland, neck, oesophagus, heart & lung
  - Hoarseness and Dysphagia
  - Decreased gag reflex, sensation in external auditory meatus, pharynx, tachycardia
Accessory Nerve (XI)

**Origin:** Cranial root: Nucleus Ambiguus (Motor)
- Accessory nucleus from Spinal cord (C1-C5).
  - Joins cranial root before passing through jugular foramen

**Distribution**
- Sternocleidomastoid & Trapezius muscles
- via fibres that join CN X (pharyngeal plexus) to striated muscles of soft palate, pharynx & larynx

**Dysfunction:**
- Wry neck
- Decreased ability to shrug shoulders or turn neck to opposite side
Hypoglossal Nerve (XII)

- **Origin:** Hypoglossal Nucleus (motor)
- **Course:** Leaves skull through **hypoglossal canal** & supplies motor fibres to the tongue & most infrahyoid muscles.
- **Distribution:** Intrinsic muscles of tongue
- **Extrinsic muscles:**
  - Genioglossus, Styloglossus, Hyoglossus, except???
- **Dysfunction:**
  - Weakness of tongue movement
  - On attempted protrusion, tongue deviates towards affected side
Summary of Cranial nerves:

Review
Clinical Anatomy

Summary of CN
5th ed. Pg 1126/7 Table 9.1
(Pg. 1058 Table 9.2 -7th ed)

5th ed. Pg 1130 Table 9.3
Summary of CN Lesions
(Table 9.6 Pg. 1079-7th ed)