SNACC QUIZ #42
UNDERSTANDING MOTOR PATHWAYS IN THE CENTRAL NERVOUS SYSTEM

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1. MOTOR SYSTEMS IN HUMANS INCLUDE ALL OF THE FOLLOWING EXCEPT:

A. Corticospinal tract
B. Corticobulbar tract
C. Extrapyramidal system
D. Spinothalamic tract
A. CORTICOSPINAL TRACT

This is true. Axons from the corticospinal tract (CST) or pyramidal tract carry information from the precentral gyrus (brodmann area 4 of the motor cortex), the supplemental, and premotor cortices (area 6) to Lower motor neurons (LMNs) which will synapse with muscle cells in the body effecting voluntary movement. While most of the fibers from this tract are from the motor cortex, some fibers originate from the primary sensory area of the brain.

B. CORTICOBULBAR TRACT

This is true. Like the CST, axons from this descending tract originate in the motor cortex and enter the brainstem synapsing on the LMNs of cranial nerves. This tract runs alongside the CST passing through the internal capsule and into the medulla oblongata (also called bulbar) before synapsing with the LMNs of cranial nerves (CN). The muscles of the face, head and neck are controlled by the corticobulbar system.


This is true. The extrapyramidal system or tracts are responsible for involuntary or automatic control of the musculature like muscle tone, balance, and locomotion. This system includes corticostriate fibers with origin in the precentral gyrus (Brodmann area 4) and the area just anterior to the precentral gyrus (4s and 6) of the motor cortex and provides information to the nuclei in the area near the internal capsule (caudate nucleus, globus pallidus, and the putamen). The Globus pallidus (main discharge center) is connected to the subthalamic nucleus (STN), Substantia Nigra (SN), the reticular formation (RF), and the red nucleus (RN). (the SN and STN are also connected to the RF and RN). A feedback loop from the Globus Pallidus connects the thalamus back to the cortex which helps to regulate movement.

D. SPINOthalamic TRACT

This is not true. The spinothalamic tract is not one of the motor systems of the central nervous system, rather it conveys sensory information from the body to the cortex. This ascending pathway conveys information regarding pain, temperature, and crude touch to the thalamus which is then relayed to the somatosensory cortex of the postcentral gyrus located in the parietal lobe of the brain.


2. ALL OF THE FOLLOWING ARE TRUE REGARDING LOWER MOTOR NEURONS (LMN) EXCEPT:

A. Alpha LMNs synapse with skeletal muscle fibers

B. LMN syndrome is characterized by weakness, atrophy, and hyperactive deep tendon reflexes

C. LMN groups are organized topographically in the spinal cord

D. The cell bodies of the LMNs are located in the brainstem and spinal cord
A. ALPHA LMNS SUPPLY SKELETAL MUSCLE FIBERS

This is true. LMNs carry information passed to them from the upper motor neurons and then synapse with the muscles of the body. There are two types of LMNs: the alpha LMNs regulate contraction of skeletal muscle to produce movement; and the gamma LMNs regulate the sensitivity of the muscle spindles for modulation of alpha LMN excitability.

B. LMN SYNDROME IS CHARACTERIZED BY WEAKNESS, ATROPHY, AND HYPERACTIVE DEEP TENDON REFLEXES

This statement is false. While denervated skeletal muscle fibers are weak and undergo atrophy, *deep tendon reflexes (DTR) are absent*. Hyperactive DTR are evident in patients with a lesion affecting upper motor neurons (UMN).

C. LMN GROUPS ARE ORGANIZED TOPOGRAPHICALLY IN THE SPINAL CORD

This statement is true. LMNs to trunk and neck muscles are found medially and LMNs distributing to muscles of distal extremities are found laterally in the spinal cord. Within spinal cord segments, LMNs distributing to flexor muscle groups are found dorsally and LMN’s distributing to extensor muscle groups are found ventrally.

D. THE CELL BODIES OF THE LMNS ARE LOCATED IN THE BRAINSTEM AND SPINAL CORD

This statement is true. The cell bodies of the lower motor neurons are located in the brainstem and the grey matter of the spinal cord and their axons leave and synapse with the muscles in the body.

3. WHICH OF THE FOLLOWING IS TRUE REGARDING UMNS?

A. **The cell bodies of the upper motor neurons are located in the spinal cord**
B. **Upper motor neurons are classified according to the pathways they travel in**
C. **The Babinski response is not characteristic of paralysis from UMN lesions**
D. **Neurological deficits due to injury affecting UMN in the central nervous system will be limited to the contralateral side only**
A. THE CELL BODIES OF THE UPPER MOTOR NEURONS ARE LOCATED IN THE SPINAL CORD

This statement is not true. Cell bodies of UMNs are located in the cerebral cortex. Axons of the UMNs will synapse with LMNs whose cell bodies are located in the spinal cord.

B. UPPER MOTOR NEURONS ARE CLASSIFIED ACCORDING TO THE PATHWAYS THEY TRAVEL IN

This statement is true. There are 6 pathways or tracts for UMN: corticospinal, corticobulbar, tectospinal, rubrospinal, vestibulospinal, and reticulospinal tract.

C. THE BABINSKI RESPONSE IS NOT CHARACTERISTIC OF PARALYSIS FROM UMN LESIONS

This is not true. The Babinski response is a sign of paralysis due to a lesion at the level of UMNs. In a healthy person, when the sole of the foot is stroked in a heel to toe direction, the toes will curl. In a patient with an UMN lesion, the toes will fan apart and the big toes will flex dorsally.

D. NEUROLOGICAL DEFICITS DUE TO INJURY AFFECTING UMNS IN THE CENTRAL NERVOUS SYSTEM WILL BE LIMITED TO THE THE CONTRALATERAL SIDE ONLY

This is not true. Injury anywhere along the pathway from the motor cortex to the spinal cord may lead to signs of UMN paralysis. The most common injury is from a cerebrovascular accident in the cerebral hemisphere before the decussation in the medulla which will cause symptoms on the contralateral side. If the injury occurs below the decussation, in the spinal cord, then the paralysis will be manifest on the ipsilateral side.

4. A 50 YEAR OLD MALE WITH AMYOTROPHIC LATERAL SCLEROSIS (ALS) PRESENTS WITH SLURRED SPEECH; A HISTORY OF DYSPHAGIA; SHORTNESS OF BREATH ESPECIALLY WHEN SUPINE; AND WEAKNESS, CRAMPING AND FASCICULATIONS IN HIS LEGS PRESENTS FOR OPEN G TUBE PLACEMENT. ON EXAM HIS RESPIRATIONS ARE DIMINISHED BILATERALLY AND THERE IS EVIDENCE OF SKELETAL MUSCLE ATROPHY. ALL OF THE FOLLOWING ARE TRUE REGARDING THIS PATIENT EXCEPT:

A. This patient is at risk for pulmonary aspiration peri-operatively
B. Hyperactive deep tendon reflexes may be evident in the same atrophic lower extremity
C. Succinylcholine is an appropriate choice for intubation for surgery in this patient
D. This degenerative disease involves the corticospinal tract

To Q 5

Back to Q3
A. THIS PATIENT IS AT RISK FOR PULMONARY ASPIRATION PERI-OPERATIVELY

This is a true statement. ALS or Lou Gehrig’s disease is a chronic, progressive, degenerative diseases that attacks the motor neurons in the brain (UMN) and spinal cord (LMN). It is not unusual for these patients to require a G-tube as in this patient or a PEG due to Bulbar involvement (LMNs of CNs) manifest by dysfunction/weakness of the pharyngeal muscles, weakness of the tongue, palate, larynx, jaw predisposing them to pulmonary aspiration. As the diaphragm weakens, patients become ventilator dependent. ALS does not impair a person’s intellectual reasoning.

Cottrell and Young’s Neuroanesthesia, 5th ed, Pa., Mosby Elsevier, 2010: Ch 21

Rowland LP, Schneider NA, Amyotrophic lateral sclerosis. NEJM,200;344(22):1688-1700
B. HYPERACTIVE DEEP TENDON REFLEXES MAY BE EVIDENT IN THE SAME ATROPHIC LOWER EXTREMITY

This is a true statement. ALS is a disease can involve both the LMNs and UMNs. The hyperactive deep tendon reflexes are due to UMN dysfunction while the atrophy is a consequent of LMN disease.


Rowland LP, Shneider NA, Amyotrophic lateral sclerosis. NEJM, 200;344(22):1688-1700

This answer is false. Succinylcholine is not an appropriate choice if relaxation is needed for surgery in this patient. The upregulation of muscle nicotinic acetylcholine receptors in patients with UMN and/or LMN defects leads to efflux of intracellular potassium into the plasma after succinylcholine placing these patients at risk for acute hyperkalemia.


Martyn et al., Succinylcholine-induced hyperkalemia in acquired pathologic states. Etiologic factors and molecular mechanisms, Anesthesiology, 2006;104:158-169
D. THIS DEGENERATIVE DISEASE INVOLVES THE CORTICOSPINAL TRACT

This statement is true. ALS is a mixed upper and lower motor neuron disease with degeneration notable in the anterior horn $\alpha$-motoneurons in the spinal cord, brainstem motor nuclei and corticospinal tracts.


5. A 50-YEAR OLD FEMALE PRESENTS TO THE EMERGENCY DEPARTMENT WITH ACUTE ONSET OF FACIAL ASYMMETRY. HER LIPS GO UP ON THE LEFT SIDE WHEN ASKED TO SMILE WHILE THE RIGHT SIDE OF HER LIPS DO NOT MOVE. ON PHYSICAL EXAMINATION THIS PATIENT IS UNABLE TO MOVE HER FOREHEAD OR LIFT HER EYEBROW ON THE RIGHT SIDE. ALL OF THE FOLLOWING NEXT STEPS SHOULD BE CONSIDERED EXCEPT:

A. A complete physical examination with attention to cranial nerve function and facial muscles

B. Prepare the patient for immediate mechanical thrombectomy and/or IV thrombolysis

C. Consider administration of steroids and acyclovir

D. No treatment is necessary as this patient will probably recover without treatment

Back to Q1
A. A COMPLETE PHYSICAL EXAMINATION WITH ATTENTION TO CRANIAL NERVE FUNCTION AND FACIAL MUSCLES

This statement is true. The first step in this patient with an apparent facial nerve lesion, is a thorough history and physical exam starting with the other cranial nerves, and the facial muscles. If this patient is unable to move her forehead/lift their eyebrow on the right side then strong consideration should be given to treatment for Bell’s Palsy, a peripheral nerve palsy of CN VII. A lesion to the LMN of the facial nerve will effect paralysis of the facial muscles on the contralateral side. If this patient with right sided facial weakness has sparing of the forehead/eyebrow on the right, serious consideration should be given to prompt imaging. The upper part of the facial nucleus which supplies the upper half of the face receives bilateral innervation from the corticobulbar tract. If this patient had a lesion at the level of the cerebral cortex (i.e left CVA) their forehead would be spared due to bilateral innervation from the corticobulbar tract. Additionally, this patient would probably have weakness of extremities on the affected side as well.

Tiemstra et al, Bell's Palsy: Diagnosis and management. American Family Physician. 2007;76(7):997-1002
B. PREPARE THE PATIENT FOR IMMEDIATE MECHANICAL THROMBECTOMY AND/OR IV THROMBOLYSIS

This statement is not true. While patients with an acute stroke from proximal intracranial artery occlusion may benefit from prompt recanalization with mechanical thrombectomy with/without IV thrombolysis with recombinant tissue plasminogen activator (rtPA), completion of a history including medications; a physical exam including the search for any other neurological deficits; and imaging is necessary before proceeding with this therapy if indicated. This patient’s isolated facial paralysis which includes the right upper and lower side of her face is more likely to be due to Bell’s Palsy.

Rabinstein, Treatment of acute ischemic stroke, American Academy of Neurology, Continuum (Minneap Minn), 2017;23(1):62-81
This statement is true. Bell’s palsy is thought to be due to inflammation to the facial nerve. Some other causes of facial nerve palsy include Lyme’s disease, otitis media, and parotid gland lesions. Assuming these and other pathologies have been investigated and ruled out, treatment with oral corticosteroids are prescribed to reduce facial nerve inflammation. Concern for possible herpes simplex virus has lead to treatment with acyclovir.

Tiemstra et al, Bell’s Palsy: Diagnosis and management. American Family Physician. 2007;76(7):997-1002
D. NO TREATMENT IS NECESSARY AS THIS PATIENT WILL PROBABLY RECOVER WITHOUT TREATMENT

This statement is true. Bell’s Palsy has a high rate of spontaneous recovery for most patients. Seventy percent of a group of 2570 patients with untreated facial nerve palsy (Copenhagen Facial Nerve Study) had complete paralysis of the facial nerve and 71% of these patients returned to full recovery. In general, patients who present with complete facial nerve paralysis have a lower rate of spontaneous recovery and therefore may benefit from treatment. Additionally, given the safety profile of acyclovir and a short course of steroids, patients who present within 3 days of symptoms should be offered treatment.

Tiemstra et al, Bell's Palsy: Diagnosis and management. American Family Physician. 2007;76(7):997-1002