بسم الله الرحمن الرحيم

# THE CORTICONUCLEAR TRACT AND APPLICATIONS

## INTRODUCTION

The term corticonuclear is equivalent to corticobulbar since 1998. Its fibers are coming from M1, premotor areas and supplementary motor from the face area (F) to control the lower motor neurons that are in the brainstem and controls whatever muscle in a the face and neck.

There are many pathways descending from the cortex to control all the brainstem nuclei, some directly and others indirectly. Indirectly by descension of the corticonuclear to the reticular formation around the nucleus then affecting through second-order neurons on the brainstem nuclei. Others through nuclei that control the these nuclei. We are concerned here about the motor nuclei excluding those related to the movement of the eye (the 3rd,4th,6th nerves).

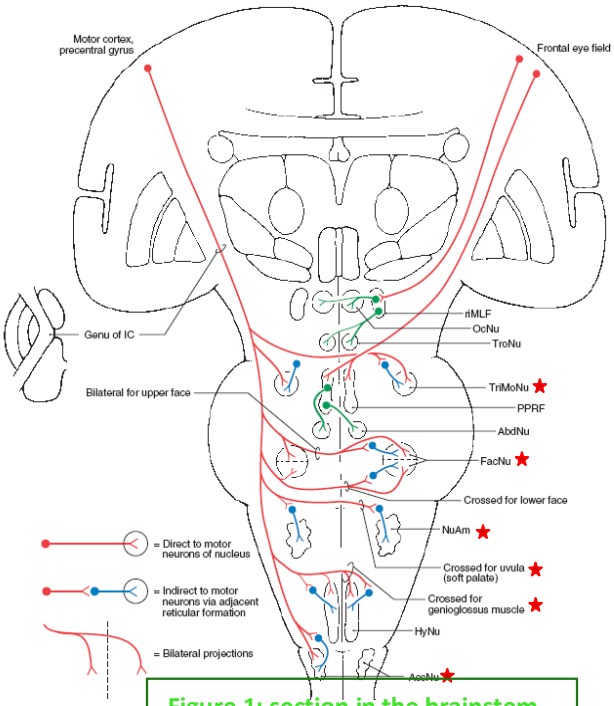


Figure 1: section in the brainstem

Motor neurons discussed in this lecture (Marked with red stars):

A. Trigeminal which controls mastication (5th)
B. Facial for facial expressions (7th)
C. Nucleus ambiguus for the palate, larynx and vocal cords (9th and 10th)
D. Genioglossal nucleus (for genioglossus muscle) (9th)
E. Accessory nerve and nucleus. (11th)

- To the right is an MRI showing the internal capsule and the corticospinal tract present in its posterior limb (red). While the corticonuclear fibers are in the genu of the capsule (yellow).

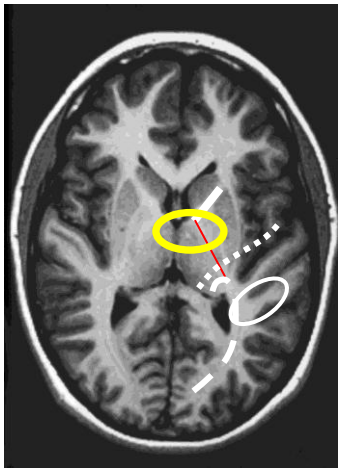

Figure 2: a horizontal section showing the internal capsule.

Now those motor neurons will descend next to the corticospinal tract (figure 3). The crus cerebi are medial to them (the corticonuclear).

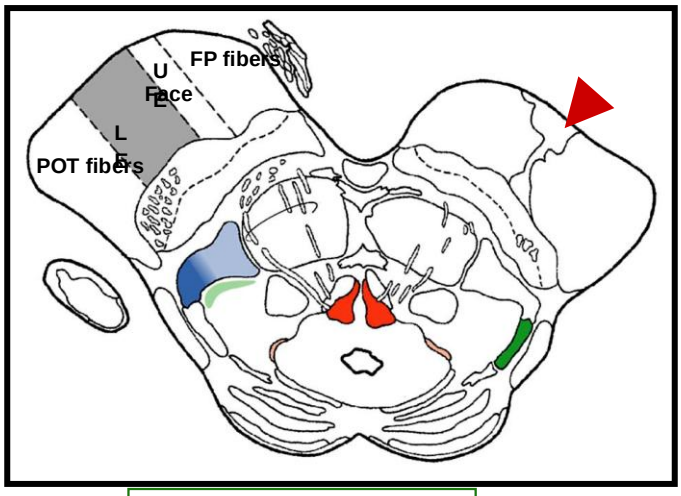


Figure 3: Section in the brainstem

Figure 4

- Notice in figure 4, there's an asymmetry due to an infarction in the posterior limb and that is why the corticospinal is smaller in that side through degeneration. Now in figure 3, on the crus cerebri there are the frontopontine fibers (FP), parieto-occipitopontine (POT) and corticospinal next to the corticonuclear (more medial). This is also the level of the exit of the occulumotor nerve.

## THE TRIGEMINAL NERVE

There are three sensory nuclei and one motor. The sensory are the spinal trigeminal nucleus (ALS), the principal nucleus (PCML) and the more rostral mesencephalon. The motor nuclei are more medial at the same level of principal nucleus and from there it will control the muscles of mastication. And because of the connection of the trigeminal nerve with the muscles of mastication it is almost a bilateral connection from cortex to the nuclei of trigeminal nerves. Almost the same amount to both right and left. And since these muscles do not have reflexes they are usually neglected in clinical testing. To stop these muscles from moving and damage their function, either the two motor nuclei must be damaged (one from each side) or a damage to the nerve itself or both the corticonuclear and the mesencephalon.

## THE FACIAL NERVE

Now this nerve controls the facial expressions and facial muscles, it is divided into upper and lower compartments. The upper compartment is almost bilateral; it takes bilateral innervation from the cortex while the lower takes only contralateral.

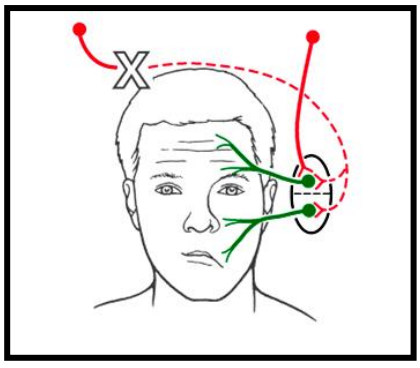


Figure 5: Central Seven

If the connection between the cortex and the facial nerve nuclei (central seven) was damaged (figure 5), there will be a paralysis in the lower part (dropping of the corner of the mouth).

While if the nucleus itself was damaged (Figure 6) or the nerve root, there will be paralysis on that side characterized by dropping of the corner of the mouth and inability to raise the eyebrow. (Bell's palsy).

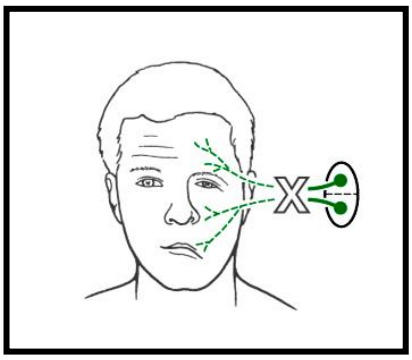


Figure 6: Bell's palsy

## SMILE

Let us divide smiling into a real smile and a fake smile.

| | |
|---|---|
| **Real Smile** | **When you are feeling happy** |
| **Fake Smile** | **When giving polite smile to people** |

- There is a smiling woman in the slides, one is real the other is not. The picture on the right is the real smile, called Duchenne smile. While the picture on the left is a polite smile, called Pan Am. Duchenne is the neuroscientist who first described it and the other is "Pan Am" because the pan-Americans were the most people smiling. The Pan Am smile is conscious and is controlled by the cortex, while the Duchenne smile mainly controlled by the limbic system.

| | | |
|---|---|---|
| **Duchenne** | **Unconscious smile** | **By the limbic system** |
| **Pan Am** | **Conscious smile** | **Controlled by cortex (corticonuclear pathway)** |

- The limbic connection will descend through the anterior limb of the internal capsule and that's why a damage in the facial cortex (the cortex for the facial movement), will cause a paralysis in the lower face. If you ask the patient to smile, it will not be an equal a smile (shifted smile) because that side will not be able to move. But if they were really smiling (real smile), it will be an equal smile because the limbic system is intact (which is in the anterior cingulate cortex).

## NUCLEUS AMBIGUUS

The 9th and 10th cranial nerves will go to the nucleus ambiguus, mainly the vagus (10th) and it goes to the uvula and the hypoglossal (12th ) which goes to the tongue.

- Notice that the uvular muscle is mainly pulling (each to its side). So if one side was weak, the uvula as a whole will move to the stronger side.
- While the genioglossus muscle in the tongue is mainly pushing, so if one side was weak, this will shift the tongue to the weak side.
- Up to here, the corticonuclear innervation came from the other side (contralateral). So if the vagus nerve nucleus or the ambiguus nucleus was damaged, the uvula (upon saying "AAA") will go to the stronger side while the tongue will go to the weaker side.
- Note: nerve 9 mainly goes to the soft palate, so it might slightly affect the swallowing or gag reflex.

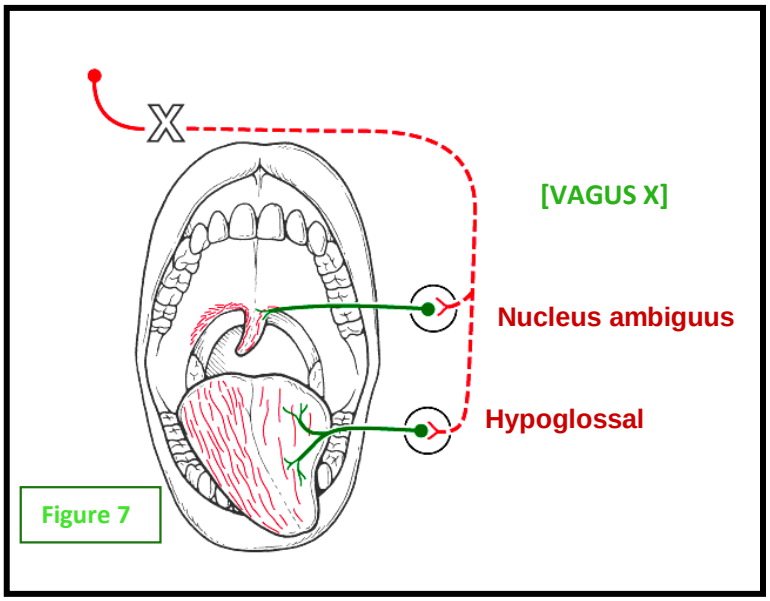

Figure 7

- The vagus nerve also supplies the vocal cords in the larynx. So a lesion, besides shifting of the tongue and uvula, will also cause difficulty in speaking and the more obvious sign is hoarseness of the voice. It is more common when the thyroid is removed. It occurs 1%, this is not a complication, it's a surgical error. It also affects swallowing.
- Removal of lymph nodes/ tonsillectomy may affect the hypoglossal N. (Check slide 19.)

## ACCESSORY NERVE AND NUCLEUS

This nerve mainly controls the trapezius and the sternocleidomastoid muscles. Its nucleus is found in the lower part of the medulla and the upper part of the spinal cord. The 'corticoaccessory' connection is ipsilateral not contralateral therefore a lesion in any of those: (nucleus, the nerve root or the upper connection), will affect the ipsilateral side. In this case, the resistance of the shoulder will be dropped or weak, and the patient cannot turn his head to the opposite side (due to the action of the sternocleidomastoid) or tilt the head to that side.

## CASE STUDY

Q: If the genu of the internal capsule was damaged. What are the consequences?

A: - Trigeminal: No effect. (Muscles of mastication are ok)

- The lower facial compartment is affected contralaterally.
- The accessory on the same side will be affected (rotating).
- And the hypoglossal contralaterally.
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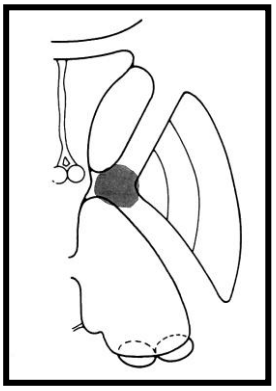
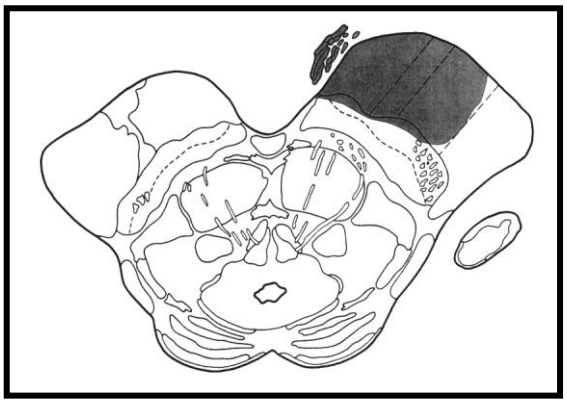


Q: This is a section through the midbrain, showing a lesion in the area of the shadow. What are the consequences?

A: … Corticospinal and frontopontine will be affected. Plus the occulomotor nerve. The occulomotor innervates the superior rectus, inferior rectus, medial rectus and the inferior oblique muscles. So that the eye will shift to the lower lateral corner.

- The occulomotor also has parasympathetic fibers that constricts the pupil. When damaged, the pupil is dilated.
  → Weber syndrome.



## SYNDROMES OF BRAINSTEM LESIONS

- Alternating plegia/lesion: when the face is affected on one side and the body on the other side. And through the facial abnormalities, the location of the lesion can be known.
- These syndromes depend on which level and which is gone.
- Slide 26 is required to be memorized for the final exam.
- Last case study was actually Weber syndrome.

## UNCUS

It is a continuation of the medial part of the temporal lobe. A hernia is a protrusion of something from a compartment to another. One of the most famous herniations is the **uncal herniation**. Figure 8 shows the location of the uncus. Any body mass through bleeding or pressure or a tumor, it will push the uncus inside and cause uncal herniation. The midbrain will be damaged, especially the crus cerebri in where many tracts (aforementioned in figure 3) pass in addition to the exit of the occulomotor nerve. Therefore an uncal herniation will damage the corticospinal, corticonuclear and the third cranial nerve; this is usually called upper alternating hemiplegia or Weber syndrome (figure 9). Also notice that the face is always the inverse of the body.

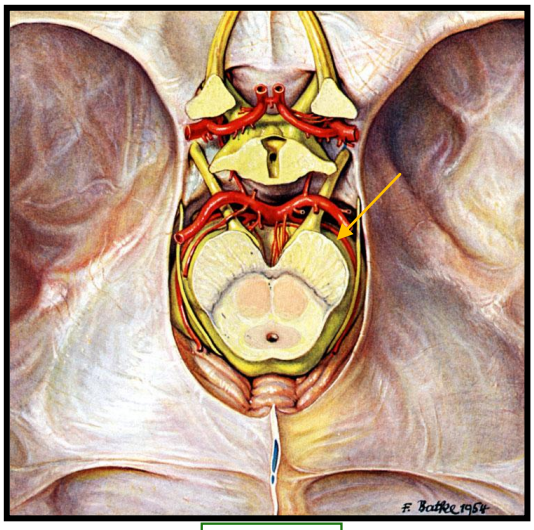



Figure 8

Now if the mass or the bleeding was chronic, the displacement will occur slowly so that the uncus will push the whole midbrain to the other side. In that case, the occulomotor of the same side will be stretched and cut while the corticospinal on the other side will be pressed and damaged. So it affects the occulomotor on one side and the crus cerebi on the other side resulting in eye and face paralysis on the same side of the body, called false localized sign or **Kernohan syndrome** (figure 10).

- There is an MRI in the slides showing the uncal herniation. It will again damage the corticospinal. It appears white which indicates neuronal death.

Figure 9

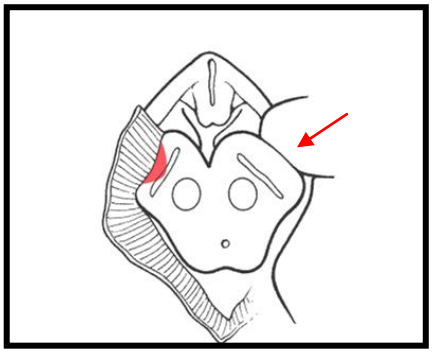


Figure 10

*Written by*

Waseem Kamal