Parkinson's Disease III

Parkinson's Disease

https://kin450-neurophysiology.wikispaces.com/Parkinson's+Disease+III

Brief Overview of Parkinson's Disease

Parkinson's Disease is a progressive movement disorder which worsens with age once a person is diagnosed. It is characterized by resting tremors, shakes, difficulty performing movements, slowed movements, stiffness, and impaired balance and posture.This disease is caused by the disintegration of the substantia nigra pars compacta which are specialized neurons located within the brain. They are a part of an overarching group of neurons called the Basal Ganglia that are responsible for movement control. The loss of these neurons cause the diminishing release of the neurotransmitter dopamine, therefore affecting voluntary and involuntary movement. Unfortunately, there is not a concrete explanation as to why the substantia nigra break down or die, but researchers have found the presence of Lewy bodies that contain a protein called alpha-synuclein in the brain cells of people with this disease. These Lewy bodies may provide more insight into the cause of Parkinson's, but more research must be conducted. As of now, there is no cure, but medication is available that increases or mimics dopamine's effects in the brain, which helps with movement control. [2,3,4]

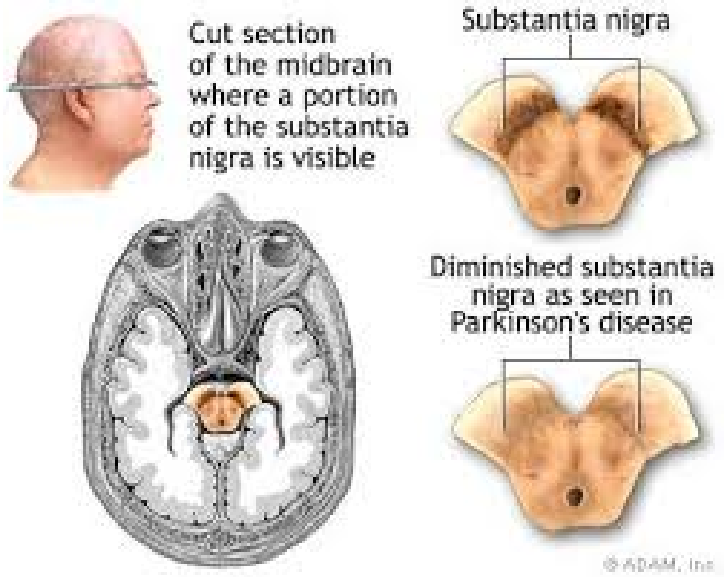

Image 1

Anatomy of the Basal Ganglia

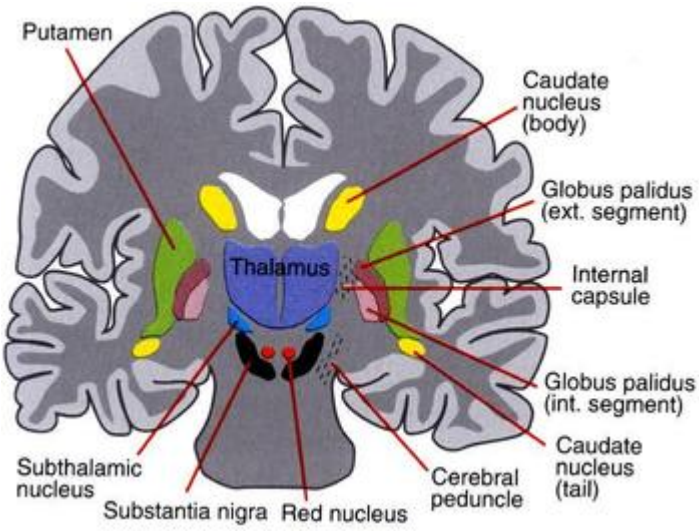

Image 2

The Basal Ganglia refers to a group of neurons that control and regulate movement. The caudate nucleus, putamen, and the globes pallidus (GP) (all of which are collectively called the corpus striatum) are located in the forebrain. The caudate nucleus is located along the lateral wall of the lateral ventricle. The putamen is separated from the caudate nucleus by the anterior limb. Together, these two structures are referred to as the striatum. The globus pallidus has two parts: an internal globus pallidus (GPi) and an external globus pallidus (GPe). The sub thalamic nuclei (STN) are located below the thalamus in the diencephalon, and the substantial nigra (SN) are located in the ventral portion of the midbrain between the red nucleus and the cerebral peduncle. There are two parts to the substantial nigra: the substantial nigra pars compacta (SNc) and substantial nigra pars reticulata (SNr). [2]

Direct and Indirect Pathways

Direct Pathway:

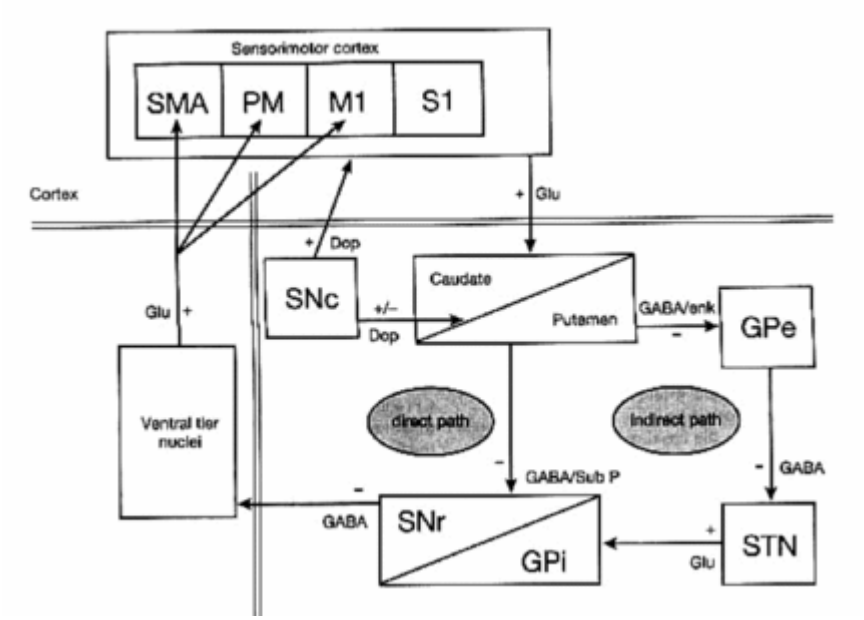

Image 3

The direct pathway is an excitatory pathway that results in releasing the thalamus from inhibition in order to excite the cortex to perform certain movement tasks. It begins with the stimulation of the striatum (caudate nucleus and putamen) by the Motor cortex. The motor cortex stimulates the striatum through the use of the neurotransmitter glutamate. The now activated striatal cells fire a signal using inhibitory neurotransmitter GABA to the internal segment of the globus pallidus (GPi). The GPi is responsible for inhibiting the thalamus, but once the GPi cells are inhibited, they release GABA neurotransmitter onto the thalamus. This double-negative inhibition actually disinhibits the thalamus, allowing the thalamic cells to release glutamate, exciting the cortex and producing movement.[1,2]

Indirect Pathway:

The indirect pathway is an inhibitory pathway that results in inhibiting the thalamus in order to inhibit excitation to the cortex. It begins with the Motor Cortex stimulating the striatum with the neurotransmitter glutamate. The stimulated striatal cells release the inhibitory neurotransmitter GABA to the the GPe cells, thus inhibiting them. The initial role of the GPe is to inhibit the subthalamic nuclei (STN), so when the GPe cells are inhibited, they also release the inhibitory GABA onto the STN. This double-negative inhibition from the GPe results in thedisinhibition of the STN, freeing the STN cells to

releasing glutamate, sending excitatory signals to the GPi. Now that the GPi cells are activated, they send inhibitory signals through the GABA neurotransmitter to the thalamus. Once the thalamus is inhibited, it will not send signals to the cortex, inhibiting the cortex from producing movement. [1,2]

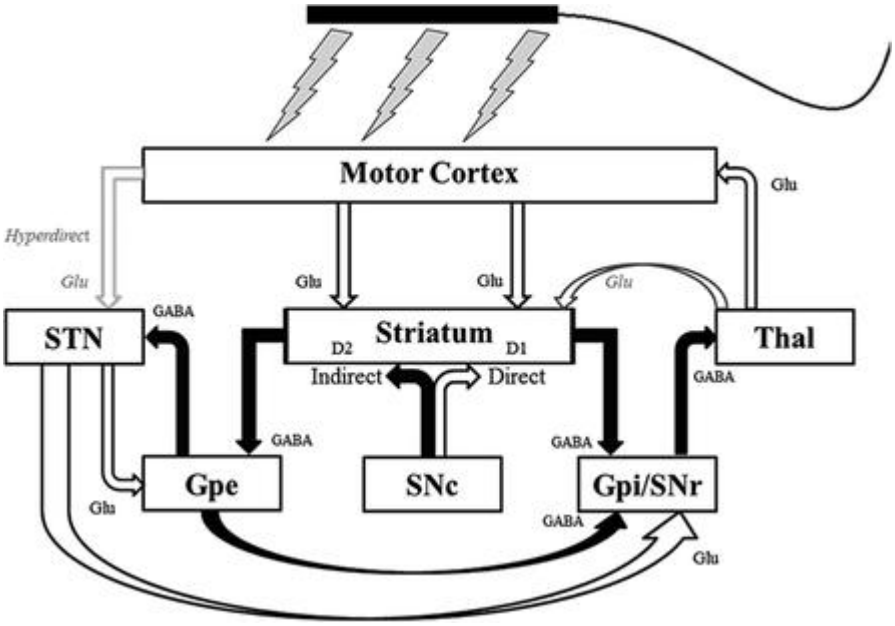

Image 4

The Nigrostriatal Pathway:

This pathway adds the effect of dopamine from the substantia nigra pars compacta (SNc) to the direct and indirect pathways. In the direct pathway, dopamine is released to the D1 receptors of the striatum causing a depolarization to the striatal cells. This has an excitatory effect on the direct pathway, strengthening the resulting excitation of the motor cortex. In the indirect pathway, dopamine is release to the D2 receptors of the striatum causing a hyperpolarization of the striatal cells. This has an inhibitory effect on the indirect pathway, thus causing the Motor Cortex to be released of its inhibition and allowing it to be excited. Therefore the action of dopamine in both pathwaysis to result in the excitation of the motor cortex, thus producing movement. The nigrostriatal pathway has a dual effect on both these pathways, working simultaneously to keep the direct and indirect pathways in balance when movement is occurring. When Parkinson's disease is present, the loss of the SNc and dopamine, produces a loss in the balance of the direct and indirect pathways. The loss of the inhibition of the indirect pathway causes this pathway to take over, which inhibits the cortex from control and producing movements, leading to the loss of movement and movement control in Parkinson's diseased patients. [1,2]

Parkinson's Disease In Depth

Diagnosis of Parkinson's Disease:

Parkinson's Disease is a chronic and progressive neural disorder that impairs the movement and non-movement abilities of an individual. This disease can be self-detected or discovered by a third party, but only confirmed by a physician. Not all patients with Parkinson's will experience the same symptoms, but the majority do. If diagnosed with Parkinson's, the signs and symptoms will get progressively worse as age goes on. The resting tremors and shakes become more dramatic. [5] There are four major motor symptoms of Parkinson's Disease:

1. Resting Tremors

The classic first sign of Parkinson's Disease is a slight resting tremor that develops in the distal extremities (hands or feet). It is characterized by a resting tremor because the tremor occurs when the muscles of the side effected are at rest. The most common tremor is called a "pill-rolling tremor" because the thumb and forefinger rub together as if the person is rolling a pill. As the disease progresses, it travels to the other side of the body. Tremors and shakes can effect other areas of the body as well, including both the upper and lower extremities, head, and neck. [5]

2. Bradykinesia

Because Parkinson's effects movement of the body, bradykinesia or "slowed movements" is a primary symptom. A person with this disease will have trouble performing daily tasks because they're movement is slowed drastically. They will also have difficulty walking and move in short, "shuffling" steps instead of picking up their feet taking one step at a time. Bradykinesia can also affect a person's speech, so slowed speech may be a symptom. [5]

3. Muscle Stiffness

In Parkinson's, muscle tone constantly remains rigid instead of producing the normal flow of contracting then resting. This leads to a decrease in a patient's range of motion and can cause a lot pain. [5]

4. Impaired Balance and Posture

People with Parkinson's have trouble maintaining balance and posture due to the loss of reflexes responsible for controlling balance and posture. They may have difficulty turning and changing their direction, standing and sitting from a chair, and walking in a normal, upright position. [5]

Causes of Parkinson's Disease

The causes of Parkinson's Disease is still unknown to this day. Researchers are trying to find the reason why the SNc dopamine releasing neurons diminishing and eventually die. However, research has been conducted that found clumps of Lewy bodies also known as the protein alpha-synuclein on the mid-brain and brainstem. The presence of these bodies

are found most cases of Parkinson's, and their location on the brain may contribute to both the movement and non-movement disabilities of these patients. More research needs to conducted on the effects of these Lewy Bodies. [4]

Treatment for Parkinson's Disease
Unfortunately, there is no cure for this disease. However, there is life long treatment that can significantly improve the quality of life for patients. Because dopamine can't be injected or "put back" in the brain, these medications act as a replacement of dopamine or help increase the amount of dopamine. The most effective medication is Carbidopa-levodopa because it converts into dopamine once it enters the brain. The downside to this medication is that its effectiveness decreases over time as the disease progresses. [4]

Movement Examples of People with Parkinson's

Summary or concluding paragraph

Parkinson's Disease can be an overwhelming diagnosis. Because there is no cure and no true understanding of why the brain
loses such an important structure contributing to movement control, it can be discouraging and seem like there is no hope. However, researchers have not stopped studying the brain searching for answers. The technological developments made have allowed so much more to be discovered, and the medications available are truly helping people live more comfortably with this disease.

Glossary of terms

1. Disintegration: The process of breaking down into small pieces or the loss of unity or integrity
2. Neurotransmitter: a chemical that transmits a nerve impulse across a synapse
3. Disinhibition: loss of an inhibition
4.Bradykinesia: slowness of movement; moving with extreme slowness
5.Tremor: trembling or shaking due to a physical weakness or disease

---

Listing of relevant links or suggesting readings (include a brief description of content)

http://www.pdf.org/about_pd
http://www.mayoclinic.org/diseases-conditions/parkinsons-disease/basics/treatment/con-20028488
http://www.neuroanatomy.wisc.edu/coursebook/motor2.pdf

Quiz questions & answers (5-10 Multiple Choice / T-F & 3-5 Short Answer / Essay)

Multiple Choice

1. The breakdown of which neurotransmitter is responsible for Parkinson's Disease?

A. GABA
B. Glutamate
C. Dopamine
D. Norepinephrine

2. Where is this neurotransmitter released from?
A. Globus Pallidus
B. Substantia nigra pars reticulata
C. Thalamus
D. Substantia nigra pars compacta

3. Which pathway results in the excitation of the cortex by the thalamus?
A. Direct Pathway
B. Nigrostriatal Pathway
C. Indirect Pathway
D. A&B

True/False

1. The loss of dopamine causes the nigrostriatal pathway to disinhibit the indirect pathway therefore causing the cortex to be restricted in producing movement. (T/F)

2. The four major motor symptoms of Parkinson's disease include tremors, hyperkinesia, balance disabilities, and muscle stiffness. (T/F)

3. There not a cure for Parkinson's Disease, but there are medications that can help treat the symptoms and better the quality of life for people with this disease. (T/F)

Short Answer

1. Describe the direct and indirect pathways of the basal ganglia.
2. Now describe how the nigrostriatal pathway influences the direct and indirect pathways.
3. What are the 4 major motor symptoms of Parkinson's Disease. Give detail for each.

References

Text References

[1] Harting, John K., P.h.D. "Coursebook." *Neuroanatomy Coursebook: Basal Ganglia*. University of Wisconsin Medical School, 2006 Jan. 21. Web. 16 Dec. 2015. <http://www.neuroanatomy.wisc.edu/coursebook.html>.

[2] Knierim, James, P.h.D. "Chapter 4: Basal Ganglia." *Neuroscience Online*. The University of Texas Medical School, n.d. Web. 16 Dec. 2015. <http://neuroscience.uth.tmc.edu/s3/chapter04.html>.

[3] Knierim, James, P.h.D. "Chapter 6: Disorders of the Motor System." *Neuroscience Online*. The University of Texas Medical School, n.d. Web. 16 Dec. 2015.

<http://neuroscience.uth.tmc.edu/s3/chapter06.html>.

[4] Mayo Clinic Staff. "Parkinson's Disease." - *Mayo Clinic*. Mayo Foundation for Medical Education and Research, 7 July 2015. Web. 16 Dec. 2015. <http://www.mayoclinic.org/diseases-conditions/parkinsons-disease/basics/definition/con-20028488>.

[5] "Understanding Parkinson's." *Parkinson's Disease Foundation*. Parkinson's Disease Foundation Inc., 2015. Web. 16 Dec. 2015. <http://www.pdf.org/about_pd>.

Image References

Image 1: http://www.nytimes.com/health/guides/disease/parkinsons-disease/print.html
Image 2: https://www.studyblue.com/notes/note/n/class-2-cns-gross-anatomy/deck/63157
Image 3: https://kin450-neurophysiology.wikispaces.com/Parkinson's+Disease
Image 4: http://journal.frontiersin.org/article/10.3389/fnhum.2013.00565/ful

Quiz Answers

Multiple Choice

1. C
2. D
3. D

True/False

1. T
2. F
3. T