

Importance of dopamine in parkinson's disease

Abstract

Dopamine is the main agent for the cause of Parkinson's disease. Parkinson's disease is progressive neurodegenerative disorder which is affected mainly to the people above the age of 50 years. Dopamine is a neurotransmitter which initiates our movement. In a patient with Parkinson's disease there is a loss of this dopamine in the substantia nigra of the brain. Hence the person loss its coordination between brain and muscle movement. As a result of which they have disturbed gait patterns and also results in tremor. The tremor is mainly found in their hands and legs. There are many environmental and genetic factors for Parkinson's disease. Research and clinicians are working in these aspects. There are many modern treatments like brain stimulation to control this disease. Drugs containing Levodopa are generally given to Parkinson's disease patient. Levodopa initiates in increasing the dopamine level. This paper emphasizes on the impact of dopamine in Parkinson's disease.

Keywords: Parkinson's disease, dopamine, neurotransmitter

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Introduction

Parkinson's disease (PD)

Parkinson's disease (PD) is a type of neurodegenerative disorder which is also a progressive disorder that causes many motor and non-motor dysfunctions.¹ These dysfunctions can be diagnosed by the study of electromyography (EMG) and electroencephalography (EEG) of the Parkinson's disease patient.^{2,3}

Symptoms of PD

Motor Symptoms

- Bradykinesia
- Rigidity
- Tremor
- Postural instability

Non-Motor Symptoms

- Neuropsychiatric
- ICDs
- Sleep disorder
- Autonomic dysfunction
- Sensory
- Other

Causes of PD

A neurodegenerative disorder is a type of disorder whose symptoms increases with disease progression. Parkinson's disease is one such disorder which is mainly cause due to loss of dopamine in the substantia nigra of the human brain. Dopamine is a neurotransmitter which helps a person to coordinate the signals from brain to muscles. Basically, dopamine inhibits human movement. A person with

Parkinson's generally loss this coordination, as a result its limb movements are disturbed Loss of this dopamine results in abnormal nerve firing patterns within the brain that cause impaired movement.⁴ Hence the loss of dopamine in the substantia nigra is the main cause of Parkinson's disease.

Environmental and Genetic factors are also responsible for PD. Environmental factors such as exposure to certain toxins such as exposure to MPTP, an illicit drug, or in people working in mining industries. These miners are mostly exposed to the metal manganese, which are also responsible for the cause of PD. Farmers exposed to insecticides and pesticides have high risk of PD. Many genetic factors are also responsible for PD. Researchers have identified different genetic mutations associated with PD, including the alpha synuclein gene, and many more genes have been also associated with this disorder. Studying the genes responsible for inherited cases of PD can help researchers understand both inherited and sporadic cases.⁵

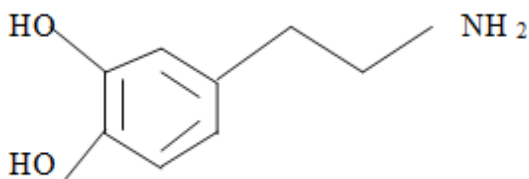
Dopamine

Dopamine is a neurotransmitter in the brain which has an important role in the functioning of the different brain activities such as motor coordination, memory etc. It also works as signaling molecule and act is a signaling pathway for the brain cells to communicate with each other. When dopamine binds to a particular receptor it activates that particular cell and as result the information's from a dopamine neuron is transmitted into another cell. Therefore, dopamine is called as a neurotransmitter.⁶

There are five different categories of dopamine receptors which are further clubbed into two, based on the action initiated by the binding of dopamine.⁷ They are:

- Dopamine receptors 1 and 5: These are considered as D1-like receptors.
- Dopamine receptors 2, 3 and 4: These are considered D2-like receptors.

The chemical structure of Dopamine is as follows:



Dopamine and parkinson's disease

The loss of the dopamine neurons in the midbrain of the human brain is the main feature of Parkinson's disease. Approximately 50%-60% of the dopamine neurons are damaged, when a person is detected with Parkinson's disease. These dopamine neurons, present in the substantia nigra of the midbrain, releases a neurotransmitter known as dopamine which is circulated into different areas of the brain. The primary regions of this neurotransmitter are the Putamen and the Caudate nucleus. The long projections of the dopamine neurons called axons, extends the brain to the putamen and caudate nucleus. In Parkinson's disease these axon extensions that project to the putamen and caudate nucleus gradually disappear. It occurs due to the disappearance of the dopamine neurons of the substantia nigra. As a result, the amount of activity in the indirect pathway increases⁸ and the thalamus is kept inhibited. Due to this condition of the thalamus, the overlying motor cortex has trouble in getting excited. The motor system is unable to work properly and hence, a person with Parkinson's disease has trouble in movement of their limbs.

The loss of dopamine-containing neurons in the midbrain affects different parts of the nigral complex up to various levels. This loss increases with disease progression. The most severe loss occurs in the ventrolateral part of the substantia nigra pars compacta.⁹ In dept knowledge of the patterns of depletion of dopamine-containing neurons in Parkinson's disease is crucial to understand its pathogenesis. Ron levy et.al worked on high- frequency oscillations (HFO) at 15-30 Hz and explored how HFOs are modulated by voluntary movements and by dopaminergic medication.¹⁰ The clinical trial of transplantation of human embryonic dopamine neurons into the brains of patients with Parkinson's disease has proved to be very much beneficial for all the clinicians and researchers working on this neurodegenerative disorder. However, this intervention would be more effective than sham surgery in a controlled trial is yet to be explored.¹¹

Summary

Treatment of Parkinson's disease requires that the levels of Dopamine be increased to decrease the symptoms of PD like bradykinesia (slow movement), rigidity, tremors and loss of balance which occurs with PD. By raising Dopamine levels slightly, symptoms

can be reduced and patient's quality of life can be improved. There are drugs which increase the Dopamine in the patient. However if the role of Dopamine in the brain is understood, it becomes easy to see how Parkinson's patient could also suffer from unusual symptoms. In fact, over 50% of Parkinson's patients suffer from PD psychosis. This includes hallucination, delusions and paranoia. Add on the effects of medication which increases Dopamine levels and the patient can have magnified levels of these really serious side effects.

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None.

Conflict of interest

The authors declare no conflict of interest.

References

1. Checkoway H, Nelson LM. Epidemiologic approaches to the study of Parkinson's disease etiology. *Epidemiology*. 1999;10(3):327-336.
2. Bunting-Perry LK. Palliative care in Parkinson's disease: implications for neuroscience nursing. *J Neurosci Nurs*. 2006;38(2):106-113.
3. de Rijk MC, Breteler MM, Graveland GA, et al. Prevalence of Parkinson's disease in the elderly: The Rotterdam Study. *Neurology*. 1995;45(12):2143-2146.
4. Valls-Solé J, Valldeoriola F. Neurophysiological correlate of clinical signs in Parkinson's disease. *Clin Neurophysiol*. 2002;113(6):792-805.
5. Surathi P, Jhunjhunwala K, Yadav R, et al. Research in Parkinson's disease in India: A review. *Ann Indian Acad Neurol*. 2016;19(1):9-20.
6. Cools R, Barker RA, Sahakian BJ, et al. Enhanced or impaired cognitive function in Parkinson's disease as a function of dopaminergic medication and task demands. *Cereb Cortex*. 2001;11(12):1136-1143.
7. Mattay VS, Tessitore A, Callicott JH, et al. Dopaminergic modulation of cortical function in patients with Parkinson's disease. *Ann Neurol*. 2002;51(2):156-164.
8. Brooks DJ. Functional imaging studies on dopamine and motor control. *J Neural Transm (Vienna)*. 2001;108(11):1283-1298.
9. Damier P, Hirsch EC, Agid Y, et al. The substantia nigra of the human brain: II. Patterns of loss of dopamine-containing neurons in Parkinson's disease. *Brain*. 1999;122(Pt 8):1437-1448.
10. Levy R, Ashby P, Hutchison WD, et al. Dependence of subthalamic nucleus oscillations on movement and dopamine in Parkinson's disease. *Brain*. 2002;125(6):1196-1209.
11. Freed CR, Greene PE, Breeze RE, et al. Transplantation of embryonic dopamine neurons for severe Parkinson's disease. *N Engl J Med*. 2001;344(10):710-719.