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Letter to the Editor

VITAMIN E ACTIVITY IN THE CENTRAL NERVOUS SYSTEM

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INTRODUCTION

Nutrients are necessary for the normal physiological function of humans and animals. Without the supply of vitamin E and mineral salts, no metabolic process in our body, including the brain, could work (1). Vitamins, identified for the first time in 1912, are organic compounds necessary for good health and lifestyle (2). However, long before it was known, foods were necessary for animal life. To date, 13 vitamins can be synthesized in a laboratory and introduced in a regular diet, although our body produces some vitamins (3).

Vitamins are classified into two large groups: water-soluble and fat-soluble (4). The fat-soluble vitamins are vitamin A or retinol; vitamin D or calciferol; vitamin E or tocopherol; and vitamin K (5). Water-soluble vitamins include: Vitamin B1 or thiamine; Vitamin B2 or riboflavin; vitamin B3 or PP and niacin; vitamin B5 or pantothenic acid; vitamin B6 or pyridoxine; vitamin B8 or H or biotin; vitamin B9 or folic acid; vitamin B12 or cobalamin, and vitamin C or ascorbic acid (6,7). Vitamin E is considered the primary fat-soluble antioxidant of all vitamins and is involved in lipid peroxidation damage (8-10). Peroxidation is a reaction involved in ageing processes and other neurodegenerative pathologies and is harmful to cells (11). High-dose vitamin E can induce nausea, headache, fatigue, double-vision, muscular weakness, and kidney issues in the central nervous system (12). Many studies on vitamin E note the effects of this antioxidant on brain tissues and memory, as it has been seen that it improves the brain-derived neurotrophic factor by antagonizing some harmful compounds (13,14). Furthermore, vitamin E in the central nervous system (CNS) prevents brain tissue oxidative damage (15).

DISCUSSION

Vitamin E, or tocopherol, is a fat-soluble vitamin with antioxidant properties, fights free radicals, protects the body from the damage of pollution and cigarette smoke and protects against the onset of cancer (16). Peroxidation is a reaction involved in ageing processes and other pathologies, such as neurodegenerative ones and is harmful to cells (17). On the other hand, specific vitamins such as vitamin E are neuroprotective and relieve neurological diseases (18). While there are no treatments to halt the progression of neurodegenerative diseases, a healthy lifestyle and a diet rich in antioxidants

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can undoubtedly improve the health and function of our cells (19). On the other hand, poor nutrition or malnutrition can cause metabolic and nervous system disorders (20) (Table I). To date, n. 8 types of vitamins E, 4 tocopherols (a, b, g, and d) and 4 tocotrienols (a, b, g, and d) have been found in nature. Vitamin E is synthesized by plants that contain alpha-tocopherol in their leaves and is extracted as an oil (21).

Table I. *Deficiencies of some vitamins that can cause disorders to the central nervous system (CNS).*

VITAMIN DEFICIENCY	CNS DISORDERS
Vitamin E	encephalopathy, nerve degeneration
Riboflavin	nerve degeneration
Thiamin	peripheral neuropathy anxiety, psychosis
Niacin	depression, dementia, dizziness, irritability, tumors
Vitamin D	tetany, demineralisation, bone deformation
Vitamin A	ataxia
Vitamin B12	irritability, peripheral neuropathy, nerve degeneration

Alpha-tocopherol comes from the diet, is not produced by our body, and is a fat-soluble molecule. Vitamin E administration is absorbed from the small intestine and is important for the diet (22). In experimental animals, it has been seen that vitamin E taken in high doses can damage bone mineralization, reduce hepatic storage of vitamin A, and cause coagulopathy. Several lines of evidence support that vitamin E circulates with chylomicrons and participates in the metabolism of very low-density lipoprotein (VLDL), low-density lipoprotein (LDL) and high-density lipoprotein (HDL). Mice genetically lacking HDL have lower alpha-tocopherol levels and impaired brain function, demonstrating that vitamin E is closely related to HDL. In addition, alpha-tocopherol can cross the endothelial cells and arrive at the brain's glial cells, which are expressed in different brain regions and made available.

It has been seen that vitamin E is essential for the health of neurons, even if its transport and regulation in the brain remain unclear at the moment (23). Vitamin E deficiency has been observed in several neurological diseases. After being taken, it crosses the blood-brain barrier, guaranteeing a fundamental nutritional contribution to the CNS.

Vitamin E is involved in ataxia, oxidative stress, Alzheimer's disease, and Parkinson's disease, where levels are low. It is unclear whether these diseases can improve after administering vitamin E (24).

Vitamin E modulates endothelial cells' function in the brain and regulates immune cell migration. Vitamin E administration is absorbed from the small intestine and is important for the diet. When given in high doses to experimental animals, a dysfunction of bone mineralization has been observed, and reused hepatic storage of vitamin A can also give a coagulopathy. Vitamin E has excellent antioxidant effects with action on both inflammation and the immune system by inhibiting the effects of tumor necrosis factor (TNF) and cellular invasiveness. Vitamin E protects against LDL oxidation and promotes anti-inflammatory responses by binding to protein kinase Cα by decreasing NF-κB activation and reducing pro-inflammatory cytokine and chemokine synthesis. This effect can occur in the brain of patients with neurological diseases. The accumulation of oxidative stress raises the levels of reactive oxygen species (ROS), which damage the mitochondria and counteract the cellular antioxidant defense mechanisms, damaging the metabolism of neurons and cerebral energy deficit. The lack of energy due to the mitochondria dysfunction leads to cell death (apoptosis), caused by an increase in the proapoptotic protein Bcl-2 Bax and Bak in the mitochondrial membrane (Fig 1).

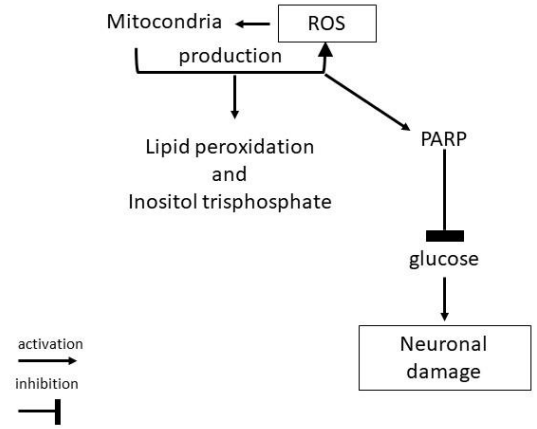

Fig. 1. *Reactive oxygen species (ROS) are generated by mitochondria but can also be produced by them under stress. The production of ROS causes lipid peroxidation and inositol trisphosphate stimulation, and ROS activate PARPs which inhibit mitochondrial glucose with neuronal damage.*

Many studies report that vitamin E, an antioxidant capable of eliminating ROS, is neuroprotective against cellular neurodegeneration. ROS are implicated in brain damage and stroke and can suppress the antioxidant defenses exerted by vitamin E, causing cell death, apoptosis, and necrosis. Many studies on vitamin E concern the effect of this antioxidant on brain tissues and also the effect on memory, as it has been seen that it improves the brain-derived neurotrophic factor by decreasing some harmful compounds (13).

CONCLUSIONS

In light of these observations, we can undoubtedly say that the daily intake of vitamin E at recommended doses can represent a preventive strategy against brain diseases, impaired-cell-mediated immunity and ageing and may alleviate the pathological state of the patient affected by cellular degeneration. On the other hand, low vitamin E levels with reduced alpha-tocopherol intake can lead to long-term central nervous system damage, and treatment of neurological patients deficient in vitamin E should be considered. However, further studies are required to establish the exact function of vitamin E in the brain.

Conflict of interest

The author declares that they have no conflict of interest.

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