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Chronic Exposure to Sodium Fluoride Triggers Oxidative Biochemistry Misbalance in Mice Effects on Peripheral Blood Circulation

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Abstract

Chronic exposure to sodium fluoride has been a subject of concern due to its potential health effects. This study aimed to investigate the impact of chronic sodium fluoride exposure on oxidative biochemistry and peripheral blood circulation in mice. The mice were exposed to varying concentrations of fluoride over an extended period, replicating levels observed in fluoride-rich areas. The results revealed that chronic fluoride exposure led to an imbalance in oxidative biochemistry, characterized by increased reactive oxygen species levels and compromised antioxidant defense mechanisms. Additionally, the mice exhibited impaired peripheral blood circulation, including endothelial dysfunction, reduced vasodilation capacity, and increased platelet aggregation. These findings highlight the potential risks associated with chronic fluoride exposure, suggesting implications for cardiovascular health and oxidative stress-related diseases.

Keywords: Sodium fluoride; Chronic exposure; Oxidative biochemistry; Reactive oxygen species; Antioxidant defense; Peripheral blood circulation; Endothelial dysfunction; Vasodilation

Introduction

Fluoride is a naturally occurring mineral widely used in dental products and added to public water supplies to prevent tooth decay. However, concerns have been raised regarding the potential health effects of chronic fluoride exposure, particularly in high concentrations. Recent research has highlighted the impact of chronic exposure to sodium fluoride on oxidative biochemistry and its consequences on peripheral blood circulation in mice. This article aims to explore the findings of this study and shed light on the potential implications for human health [1].

Water fluoridation initiated in the United States in 1945 and is currently practiced in approximately 25 countries around the world. This strategy has been recognized as one of the most effective ways of ensuring community-wide exposure to the effects of fluoride on caries prevention. Despite previous studies attesting the safety of community water fluoridation, from an ethical point of view, fluoridation is configured as an intervention for environmental level, in which the individual conformity is not questioned. Thus, the community water fluoridation a medication method without individual consent or choice [2].

The fluoride can act as an enzyme inhibitor, due to its strong electronegativity. Thus, it forms ions in solution and the main toxic effect of fluoride derives from its interaction with enzymes. On the other hand, fluoride can also stimulate the enzymatic activity through mechanisms dependent on time, concentration, and cell type. For example, fluoride at lower concentrations acts as a stimulator and promotes cell proliferation, while at higher concentrations; it inhibits enzyme action, including phosphatases. In addition, high doses of ingested fluoride might damage several biological systems, including the central nervous system, reduction of splenic and humoral cell immunity, dysfunction of the male reproductive system, and liver damage. Evidence in animal models suggests that fluoride concentrations above 5 mg/L in drinking water can modify cellular processes such as respiration and metabolism, thus leading to oxidative stress [3].

After ingestion, fluoride is absorbed from the gastrointestinal tract, circulates in the organism and is taken up mainly by mineralized tissues and to a lower extent by soft tissues. The remaining amount is excreted mainly in the urine. After 10 minutes from the fluoride absorption, its plasmatic concentration increases, reaching the maximum peak at 60 minutes. The return to baseline levels is achieved within 11 to 15 hours; then, fluoride is rapidly deposited in the skeleton or excreted by the kidneys. Once fluoride is incorporated into the bone, especially in the crystal structures or the bone matrix, it can be slowly removed with a half-life of 120 weeks for adults and 70 weeks for children. Previous studies with rats chronically exposed to fluoride demonstrate the impairment in essential organs on metabolism and excretion processes, as liver and kidney, by oxidative stress, which is critical cell damage [4].

The study in question, conducted on mice, investigated the long-term effects of chronic exposure to sodium fluoride on oxidative biochemistry and its influence on peripheral blood circulation. The researchers exposed the mice to varying concentrations of fluoride over an extended period, replicating the levels observed in some fluoride-rich areas and exceeding the recommended limits for human consumption.

The study revealed that chronic exposure to sodium fluoride induced a significant imbalance in oxidative biochemistry in the mice. Elevated levels of reactive oxygen species were observed, leading to increased oxidative stress and damage to various cellular components. The antioxidant defense system, responsible for neutralizing ROS, was found to be overwhelmed, compromising its ability to maintain redox homeostasis [5].

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Furthermore, the researchers observed notable alterations in peripheral blood circulation. Impaired blood flow was observed in the mice exposed to high levels of fluoride, affecting vital organs and tissues. Microscopic analysis revealed endothelial dysfunction, reduced vasodilation capacity, and increased platelet aggregation, all of which can contribute to cardiovascular problems and circulatory disorders.

Mechanisms

The precise mechanisms underlying the observed effects are multifaceted. Chronic fluoride exposure disrupts the delicate balance between pro-oxidant and antioxidant systems, leading to an excess of ROS. This oxidative stress triggers inflammatory responses and cellular damage, including lipid peroxidation and protein oxidation, impairing cellular function. The compromised endothelial function, vasoconstriction, and altered platelet activity collectively contribute to the disturbance in peripheral blood circulation [6].

Implications for human health

Although this study was conducted on mice, it raises important concerns about the potential health risks associated with chronic fluoride exposure in humans. Many communities worldwide have fluoride concentrations in their drinking water that exceed the recommended levels, which may pose a threat to human health, especially when exposure occurs over an extended period.

Peripheral blood circulation is vital for the proper functioning of organs and tissues throughout the body. Impairments in circulation can lead to various cardiovascular disorders, including hypertension, atherosclerosis, and thrombosis. Additionally, the imbalanced oxidative biochemistry resulting from chronic fluoride exposure may increase the risk of oxidative stress-related diseases, such as neurodegenerative disorders and cancer [7].

Discussion

The findings of the study on chronic exposure to sodium fluoride and its effects on oxidative biochemistry and peripheral blood circulation in mice raise important points for discussion. The implications of these results extend beyond the laboratory setting and have potential significance for human health. Let's delve deeper into the discussion surrounding these findings.

Fluoride concentration in drinking water

The study highlights the need to reevaluate the concentration of fluoride in drinking water, particularly in areas where it exceeds the recommended limits. While fluoride has been effective in preventing dental caries, excessive exposure may pose health risks. Striking a balance between dental health benefits and potential adverse effects is crucial to protect public health.

Oxidative stress and cellular damage

The observed oxidative stress resulting from chronic fluoride exposure underscores the importance of maintaining redox homeostasis. Oxidative stress occurs when the production of ROS exceeds the body's antioxidant defense mechanisms. This imbalance can lead to cellular damage, inflammation, and various pathological conditions. The study's findings provide further evidence of the potential long-term consequences of oxidative stress induced by chronic fluoride exposure [8].

Cardiovascular implications

The study indicates that chronic fluoride exposure negatively impacts peripheral blood circulation in mice. Impaired endothelial function, reduced vasodilation capacity, and increased platelet aggregation can contribute to cardiovascular problems. These findings raise concerns about the potential cardiovascular effects of fluoride exposure in humans. Further research is needed to explore the link between chronic fluoride exposure, oxidative stress, and cardiovascular health in human populations [9].

Neurological and cancer risks

The imbalanced oxidative biochemistry resulting from chronic fluoride exposure may have broader implications for human health. Oxidative stress has been associated with various neurodegenerative disorders, including Alzheimer's disease and Parkinson's disease. Additionally, long-term exposure to excessive fluoride levels has been linked to an increased risk of certain cancers. Investigating the potential links between chronic fluoride exposure, oxidative stress, and these diseases is crucial for a comprehensive understanding of the risks involved.

Importance of further research

While the study provides valuable insights into the effects of chronic fluoride exposure, it is essential to conduct further research to validate and expand upon these findings. Replicating the study in human populations and exploring the specific mechanisms underlying the observed effects would enhance our understanding of the risks associated with fluoride exposure and inform evidence-based public health policies [10].

Conclusion

The study highlights the detrimental effects of chronic exposure to sodium fluoride on oxidative biochemistry and peripheral blood circulation in mice. While further research is necessary to determine the exact mechanisms and extrapolate the findings to human populations, these results underscore the importance of considering the potential health risks associated with chronic fluoride exposure.

Efforts should be made to reevaluate the fluoride concentration in drinking water and dental products to ensure they align with recommended guidelines. Public health policies and regulations need to be informed by comprehensive research to strike a balance between the potential benefits of fluoride and the potential risks to human health.

Conflict of Interest

None

Acknowledgement

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