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The role of dietary education and vitamin supplementation in the treatment of Allergic Rhinitis

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SUMMARY

Introduction and purpose

Allergic rhinitis (AR) is a widely prevalent condition which affects mainly children. The disease is not as severe as other allergic disorders; however, its symptoms significantly impact the patient's quality of life. The therapeutic options have limited effectiveness and they are burdened with numerous side effects. In addition, AR's underlying causes are not fully elucidated; thus, there is an urgent need to conduct more large sample studies on this topic.

State of knowledge

In recent years, research concerning the role of vitamin deficiency in AR pathogenesis gathered pace. Some studies report that children with vitamin A, C and D deficiencies more often suffer from allergic diseases, especially AR and asthma. Furthermore, they are more likely to have severe infections and other disorders caused by immune imbalance. The crucial aspect of vitamins' role in AR is their significant ability to modulate the immune response, especially adaptive, by restoring Th1/Th2 balance. Recent publications reported that vitamin supplementation in AR patients results in an improved clinical course of the disease and restored immune balance. Moreover, vitamins added to the typical treatment improve its effects.

Conclusions

This review aims to summarize the state of knowledge about the role of vitamin A, C and D deficiency in the pathogenesis of AR. Moreover, we point out the values of education in the field of proper dietary habits among AR patients. In addition, the effects of vitamin supplementation in AR patients are also emphasized.

Keywords: vitamin A; vitamin C; vitamin D; allergic rhinitis; allergy; education

1. INTRODUCTION AND PURPOSE

Recent years have yielded plenty of information about the significant impact of vitamins on human's health. Vitamin A is a regulator of cell and tissue growth and differentiation. Vitamin D provides a hormone-like function and regulates metabolism. Vitamins C functions as antioxidant [1]. However, their significant impact on the immune system remains underestimated.

Interestingly, in recent years, the worldwide burden of allergic diseases is also observed. Allergic rhinitis (AR) affects mainly children up to 40% of the population. The most common AR symptoms are rhinorrhea, sneezing, blocked and itchy nose. They significantly affect patients' quality of life and lead to sleep disturbances or learning disabilities [2]. Currently, the AR treatment is based mainly on symptomatic drugs which improve the clinical course of the disease. However, their effectiveness is limited, and they are burdened with side effects [3]. Thus, there is an urgent need to find a novel, effective therapeutic approaches. The underlying causes of AR are not fully elucidated. It is presumed, that genetic factors, exposure to allergens in childhood, food, infectious and toxic agents modulate the immature immune system and lead to allergy development [2]. Furthermore, many studies reported that vitamins deficiency may be also associated with the development of AR.

This publication aims to summarize and briefly explain the link between vitamins A, C and D deficiency and the development of AR. We also emphasize the significant role of education in the field of proper dietary habits in AR patients. Furthermore, the clinical outcomes of vitamins supplementation in AR patients are also discussed.

2. DESCRIPTION OF THE STATE OF KNOWLEDGE

2.1. EDUCATION AND DIETARY HABITS

In the last decade, some studies reported the protective effect of the Mediterranean Diet on asthma, AR and eczema. This phenomenon suggests that high vegetables and fruit intake in which the diet is high might be a practical approach to reducing the risk of allergies [4]. However, mentioned diet is prevalent mainly in the Mediterranean region. Thus, an urgent need is to educate AR patients on providing proper vitamin intake. Rasmussen et al. reported that 8,9% of Dutch adolescents eat vegetables less than once a week [5]. Thomson et al. pointed out that behaviour-based interventions resulted in increases in daily fruit and vegetable intake [6]. Andrusaityte et al., in 2017, presented a study investigating the relationship between the consumption of fruit, vegetables, nuts, meat and fish and the prevalence of wheeze, asthma, and eczema among preschool children. It showed that wheezing was observed more often among children who did not eat vegetables [7]. Moreover, Wang et al., who examined the association between fast food consumption and the severity of allergic diseases, observed that the consumption of fast foods, especially hamburgers, ≥ 3 times/week, was more likely to be associated with severe asthma and current wheeze compared with the consumption of 1-2 times/week [8]. Schools can play an essential role in the education and promotion of healthy eating among children. It was shown that experimental learning strategies (school/community garden, cooking and food preparation activities) were associated with the best effects across the increased fruit and vegetable intake [9]. Furthermore, Schmidt et al. reported that children who participated in a Culinary Education Program liked the event and improved their dietary habits [10]. Thus, it can be presumed that dietary education in schools may be a promising way to promote proper nutritional practices in children, especially those suffering from AR.

2.2. VITAMIN A

2.2.1. Deficiency

Vitamin A is a fat-soluble micronutrient which constitutes the group of retinoids. Its main active form – retinoic acid (RA) is involved in multiple physiological processes such as vision, immunity and cellular differentiation [11]. It has been shown that vitamin A has a huge role in regulating homeostasis at the mucosal surface. It is able to polarize the phenotype of mucosal dendritic cells (DCs), induce differentiation of T cells and regulate the balance of Th1/Th2 responses [12]. Yang et al. demonstrated in an animal model that vitamin A deficiency enhances the Th2 type response, which worsens allergy symptoms. Furthermore, in mice deficient in vitamin A, higher serum IgG1, IgE, IL-4 and IL-13 levels were observed [13]. Similar findings were shown by Hufnagl et al., who concluded that said immune abnormalities promote allergic symptoms exacerbation along with enhanced lung inflammation [14]. Moreover, Turfkruyer et al. suggest that a physiological vitamin A deficiency in neonatal mice leads to inefficient oral tolerance. This phenomenon was presumably caused by inefficient T-cells activation [15].

2.2.2. Supplementation

Son et al. investigated the effects of RA in a mouse model of AR. The study showed a significant improvement in symptom severity after the treatment. Moreover, the levels of IgE, Foxp3, TGF- β , and IL-10 mRNA were

lower in the therapeutic group compared with the placebo [16]. Similar findings were presented by Feng et al., who examined the effects of vitamin A on the severity of AR and asthma in mice. The levels of IgE, IL-4, IL-5, IL-17, and IL-33, eosinophil peroxidase activity, perivascular and peribronchial inflammation significantly decreased in vitamin A-treated asthma and AR groups compared to non-treated groups [17]. Only one human study investigating the effect of vitamin A on AR patients was conducted. Lauriello et al. investigated the effects of liposomal nasal spray with vitamins A and E on AR patients. Participants were enrolled into study and placebo groups and applied the sprays two times a day for 30 consecutive days. The study showed that spray was effective in improving both nasal symptoms and cytology in patients suffering from perennial AR. However, bearing in mind that the preparation consisted of both vitamin A and E it is hard to conclude whether the said alleviation was caused by vitamin A [18]. To conclude, the data concerning the impact of vitamin A on AR clinical course is still insufficient; nevertheless, its use may be a potential new therapeutic approach.

2.3. VITAMIN C

2.3.1. Deficiency

Vitamin C is an essential micronutrient which cannot be synthesized by the human body. It is a potent antioxidant and a cofactor for multiple enzymes. Moreover, it contributes to immune defence by supporting cellular functions of both the innate and adaptive immune systems. For instance, it supports epithelial barrier functions, enhances phagocytosis, and promotes differentiation and proliferation of B- and T-cells [19]. It has been shown that vitamin C deficiency may lead to allergy development. Hoppu et al. reported that vitamin C in breast milk might reduce the risk of atopy in infants [20]. Furthermore, Harik-Khan et al. showed that low vitamin C intake is associated with higher asthma risk in children [21]. Allen et al., in their meta-analysis, concluded that lower quantile dietary intakes and serum levels of vitamin C were associated with an increased odds of asthma [22]. Unfortunately, there is no data concerning the role of vitamin C deficiency in AR development. However, the results of mentioned studies suggest that the increased risk of AR may also be possible.

2.3.2. Supplementation

Only two studies examined the effects of vitamin C supplementation on the clinical course of AR. In 2018 Vollbracht et al. enrolled 71 patients with allergic diagnoses (AR, asthma, eczema, psoriasis, urticaria). Each patient received iv vitamin C (PascorbinVR 7.5 g/50 mL) diluted in a suitable carrier solution such as 100 mL NaCl 0.9%. The main study parameter was the change in symptoms during the iv vitamin C treatment. Therefore, at the beginning (visit 1) and end of the observation period, the severity of each symptom was scored. Treatment was performed during a mean of 3.2 weeks for acute disease and 11.9 weeks for chronic disease. During the observation period, symptoms improved in 67 (97.1%) of the 69 analyzed patients [23]. To further expand the research, Tongtako et al. investigated the effects of aerobic exercise and vitamin C supplementation on rhinitis symptoms in AR patients. They enrolled 27 patients and assigned them to 3 groups: control, exercise and exercise combined with the vitamin C. The exercise training protocol consisted of walking and/or running on a treadmill at 65-70% heart rate reserve for 30 min per session, 3 times per week for 8 weeks. After the observational period, patients in both exercise and exercise combined with vitamin C group had increased peak aerobic capacity and peak nasal inspiratory flow and exhibited significantly decreased rhinitis symptoms. Furthermore, they had significantly lower nasal secretion IL-4, but higher IL-2 levels [24].

2.4. VITAMIN D

2.4.1. Deficiency

Vitamin D deficiency and insufficiency is a global health issue that affects more than one billion children and adults worldwide [25]. The consequences of this phenomenon cannot be underestimated. Among them, the most important are rickets in children, osteoporosis in adults, and several extra-skeletal effects like pregnancy-related complications and immune dysfunctions. Furthermore, vitamin D deficiency is reported in several chronic conditions associated with increased inflammation and dysregulated immune system. There are two important non-classical actions of vitamin D: the expression of the vitamin D receptor (VDR) on the majority of immune cells and the metabolism of vitamin D by immune cells. It has been shown that vitamin D promotes dendritic cells and T regulatory cell differentiation and reduces inflammatory cytokines secretion [26]. Recently, Matsui et al. reported that vitamin D deficiency is linked to food allergy development [27]. Dogru and Suleyman compared the serum 25(OH)D3 levels in children with AR with the control group. They found that the mean serum 25(OH)D3 levels of the children with AR were lower than the control group. However, they did not find any relationship between vitamin D levels and the severity of AR [28]. On the other hand, Wjst and Hyppönen analyzed the association between serum 25(OH)D3 levels and AR prevalence in adults. They found that AR prevalence increased with levels of 25(OH)D3 in all subgroups. It suggested that vitamin D supplementation in infancy or high levels of 25(OH)D3 was positively related to AR prevalence in adults [29]. We can conclude that experimental data support a link between vitamin D and AR; however, the exact mechanism of vitamin D action remains unclear.

2.4.2. Supplementation

In 2020 Bhardwaj et al. enrolled 87 AR patients and divided them into 2 groups. Group A was administered with intranasal steroidal spray, while Group B was given vitamin D supplementation along with intranasal steroidal spray. The study lasted for 4 weeks. It was found that adding vitamin D to nasal steroid spray showed statistically significant improvement in post-treatment symptom scores [30]. Bakhshae et al. aimed to determine whether a short-term vitamin D supplementation can improve the clinical course of AR. They enrolled 80 AR patients with vitamin D deficiency and divided them into 2 groups. The study group received cetirizine with vitamin D, while the placebo group was administered with cetirizine and placebo tablet. The clinical symptoms were noted at the baseline, after 4 weeks and after 8 weeks of treatment. Analysis showed that no differences were observed after 4 weeks, but after 8 weeks, patients from the study group had significantly decreased symptom scores [31]. Furthermore, Jerzyńska et al. examined the clinical and immunological effects of vitamin D supplementation during the pollen season in children with AR. They enrolled 38 children aged 5-12 with the diagnosis of seasonal AR and divided to 2 groups. Patients received either vitamin D 1000 IU daily supplementation or a placebo. The study showed that vitamin D therapy was effective in the reduction of the symptoms or/and medication score [32]. Based on the mentioned findings, it can be concluded that vitamin D supplementation can result in symptoms improvement.

3. CONCLUSIONS

To sum up, it seems highly probable that vitamins play a role in the pathogenesis of AR. With ever-growing evidence published in that field, the hope for the new prevention and therapy of AR is growing in parallel.

It is believed that immune system imbalance is linked with vitamin deficiencies. The wide range of their properties impacts the developing immune system. Thus, early-life disturbances in vitamin intake may affect future host's immunity and lead to allergy. However, the supplementation of AR patients with vitamins A, C and D seem a promising therapeutic approach to restore the mentioned imbalance.

In the future, it will probably be possible to identify patients with an exceptionally high allergy risk due to their vitamin insufficiencies. Nevertheless, more rigorous, and detailed trials are demanded to draw definitive conclusions.

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