

Correlation of Hypovitaminosis D and Hypocalcaemia with Dental Caries

About the Author(s)

*Nusrat Ali¹, Seemeen Ghafoor,² Farzana Majeed³, Momin Iqbal⁴, Hassanain M Naqvi², Maryam Fatima⁵.

¹Assistant Professor of Biochemistry, HBS Medical and Dental College, Islamabad

²Professor of Biochemistry, HBS Medical and Dental College, Islamabad

³Associate Professor of Physiology, HBS Medical and Dental College, Islamabad

⁴Demonstrator in Biochemistry, HBS Medical and Dental College, Islamabad

⁵Demonstrator in Pathology, HBS Medical and Dental College, Islamabad

*Correspondence: smanizah75@gmail.com Received: December 09, 2020 Accepted: February 13, 2021
Assistant Professor Department of Biochemistry, HBS Medical and Dental College, Islamabad.

Abstract

Objective: To find out the association of dental caries with hypovitaminosis D and hypocalcaemia.

Methodology: This study Cross sectional study was conducted at Islamic International Medical College from September 2015 to March 2016. Children, between 2-8 years of age, were selected. They were eighty in number and were placed into two groups. Group 1 consisted of children with compromised dental health and their number was sixty. Children with healthy dentition were twenty in number and were placed in group 2. To measure the extent of caries, we followed the diagnostic criteria given by WHO. Caries score was calculated from dmft index (decayed, missed, filled teeth). Calcium levels of the study population were determined by a direct colorimetric complexometric test (Arsenazo III) using microlab 200. Levels of 25-hydroxyvitamin D (25-OHD) was measured from serum samples by using enzyme linked immunosorbent assay (ELISA). Correlation analysis was done with Pearson correlation and t test was applied to the results.

Results: Results have established that dental caries is prevalent in children with hypovitaminosis D and hypocalcemia. The t test has indicated that in children with hypovitaminosis D and with hypoplastic tooth surfaces, more non-cavitated and cavitated carious lesions were found than in children with normal vitamin D and calcium levels and having sound enamel surfaces and well-formed teeth ($p = 0.01$). This cross-sectional study has shown that caries, hypoplastic tooth surfaces, poorly mineralized teeth, and dental caries are directly related with each other.

Conclusion: Dental caries, hypovitaminosis D, lower calcium levels, hypoplastic tooth surfaces and poorly mineralized teeth are closely linked. Improving children's vitamin D and calcium levels by providing knowledge about vitamin D and calcium-rich foods and supplementation can help decrease the incidence of dental caries in young children and is a step towards strong bones and teeth.

Key Words: Decayed, Missed, Filled Teeth (DMFT), 25 Hydroxy Vitamin D (25OHD).

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Introduction

Vitamin D is also known as calciferol is fat soluble sterol derived vitamin. It is a prohormone. Its two forms are vitamin D₂ and vitamin D₃. Vitamin D₂ or ergocalciferol is derived from plants, vitamin D₃ or cholecalciferol is synthesized in human skin from 7 dehydrocholesterol,¹ on exposure to ultraviolet B irradiation with wavelength 290 to 320 nm, 7dehydrocholesterol is converted to D₃.² Serum vitamin D levels depend on not only on Sun exposure but also on its dietary supply. Few of these dietary sources include cod liver oil, fishes like salmon, sardines, cod fish and mackerel, red meat and liver.³

Vitamin D deficiency in humans produces defects in bone mineralization resulting in disease, rickets which occurs in children and osteomalacia, occurs in adults. Vitamin D also has a definitive role in regulating acquired and Innate Immunity immune response. Calcitriol also effect the differentiation and mineralization of osteoblasts. Vitamin D level is measured from plasma concentration of the circulating 25(OH)D.⁴ Serum 25(OH)D levels < than 20 ng/ml shows deficiency: serum 25(OH)D levels between 20-30 ng/ml denotes insufficiency: 30-44 ng/ml as sufficiency and 50-70 ng/ml is considered as optimal level.⁵

Calcium is one of the most important mineral of human body as it is the part of bony skeleton and teeth. 99% of calcium occurs in bones. Calcium plays an important role in the nerve conduction, muscles and heart contraction.⁶ Calcium acts as second messenger for certain hormones. It activates clotting factors in plasma. There should be sufficient calcium in the diet of children for their health, growth and proper functioning of bodies. Milk, cheese and yoghurt are the best sources of calcium.⁷ Egg yolk, fish, nuts like almonds and green leafy vegetables like broccoli, spinach also contain sufficient amount of calcium. Children, as well as adult, should incorporate such foods in their diet so as to fulfill the calcium requirement.⁸ Normal serum calcium levels are 9-10.5 mg/dl.⁹ Hypocalcemia is defined as total serum calcium levels below 8.7 mg/dl.^{10, 11}

An active form of vitamin D, calcitriol increases the absorption of calcium by inducing the synthesis of special transport protein Calbindin in the intestinal epithelial cells⁽¹²⁾. Parathyroid hormone and Calcitonin are involved in the homeostasis of calcium¹³ and maintain the blood calcium level within a narrow range.

When there is hypocalcaemia, parathyroid hormone stimulates bone resorption, increases calcium reabsorption from distal convoluted tubules of kidney and increases the intestinal absorption of calcium by converting 25 Hydroxy Vitamin D (25OHD) into 1,25 dihydroxy Vitamin D (1,25(OH)₂D), the active form of vitamin D in the kidneys.⁴

Certain diseases, like hypoparathyroidism, rickets and renal osteodystrophy affect calcium homeostasis.¹⁴ Thus blood calcium levels cannot be maintained, which will lead to hypocalcemia. If there is nutritional deficiency of vitamin D or active form of vitamin D cannot be synthesized by kidney due to certain pathology then it will also lead to hypocalcemia.¹⁵ Hypomagnesemia and hyperphosphatemia may also disrupt calcium metabolism and hypocalcemia will be inevitable.¹⁶

An early symptom of hypocalcaemia is paresthesia around mouth, hands, arms and legs. Lethargy and poor muscle tone may also be seen.¹⁷ Later the bones weaken, the risk of tooth decay and caries also increases. Growth and development of children is compromised.¹⁸ In adults osteoporosis develop. Prolonged vitamin D deficiency, decrease serum calcium levels and increase parathyroid hormone result in tooth decay and more carious lesions.

If hypocalcaemia is present at the time of tooth development then there will be poor mineralization of tooth and it might be shown as enamel hypoplasia.^{19, 20} Dentinal tubular defects may appear, the occlusal surfaces of posterior teeth may show abnormally deep

fissures. The anatomy of pulp chamber may also be disrupted with large chambers and raised pulp horns accompanied by thin layer of enamel.^{11,13} The dentinoenamel junction may also show defective mineralization. Such teeth are more prone to caries. Because of defective mineralization and enamel hypoplasia the bacteria which cause caries, accumulate in that region and cause visible dissolution of enamel which later on develop in carious defect.²⁰

There should be some definitive regime for improving the health of growing children and increasing their awareness about dairy consumption, so that deficiency of vitamin D and calcium can be avoided.

The present study aims to investigate the correlation of vitamin D insufficiency and hypocalcaemia with dental caries in primary dentition. Our hypothesis is that vitamin D deficiency and hypocalcaemia are present in children with multiple carious teeth.

Methodology

It was a cross-sectional observational study, held in the Biochemistry department of IIMC-T (Islamic International Medical College) Rawalpindi in collaboration with IIDC (Islamic International Dental College) Islamabad after the approval from Institutional Review Committee, and Ethics Committee of Riphah International University from September 2015 till March 2016. The size of the sample was calculated, based on prevalence and duration of study period. Sixty Children with multiple caries were designated as group 1 and twenty children with sound, healthy teeth as group 2. The diagnosis of childhood caries was based on oral health diagnostic criteria defined by WHO. Total caries score, dmft index (decayed, missed, filled teeth) was obtained. Simple randomized sampling technique was used for sample collection. The patient were allocated without any bias or prior notification during the entire study period. Study samples were collected from different hospitals to ensure a fair degree of randomness.

Venipuncture of participants was done to determine serum vitamin D and calcium levels. Serum samples were stored in freezers of post graduate laboratory at -70°C, Biochemistry department of IIMC Rawalpindi. For data processing SPSS 21 was used. Frequencies, means and standard deviations were determined. *t* test was also applied. *p* value less than 0.05 was considered as significant.

Results

Results have established an association of low vitamin D and calcium levels in children with early childhood

dental caries. Total number of children participated in the study was 80. In them 43, 54% were male and 37, 46% were female. The mean age of the patient was 5 years and 3 months.

In table I *t*-test has showed that Childhood Caries has significant association with calcium levels. Statistically significant difference (p value less than 0.001) is seen in calcium levels of sample population with caries and without caries.

In table II, *t*-test has showed that Childhood Caries has significant association with Vitamin D levels. A statistically significant difference (p value less than 0.001) is seen in vitamin D levels of sample population with caries and without caries.

In table III, Combined correlation of Vitamin D levels, calcium levels and dental caries has revealed that Vitamin D and calcium level have positive correlation of value 0.946 whereas, vitamin D and calcium levels have reverse correlation with caries of values -0.890 and -0.827 respectively with p value is 0.00 and correlation is significant at the 0.01 level.

Discussion

The current study examined the correlation of vitamin D and calcium levels with extent of dental caries. This study has showed that calcium deficiency is significantly related with tooth decay or carious lesions. Hypovitaminosis D and Hypocalcaemia are strongly correlated to extent of dental caries in childhood.

Present study has also revealed that dental caries was more prevalent in children who had enamel and dentine defects. This conclusion is also in accordance with a study conducted on dental caries in preschool children by Carvalho et al who concluded that children with hypoplastic enamel had more carious teeth²¹ Paixão-Gonçalves et al in 2019, also established that children with enamel defects had more chances of having dental caries²²

Hypocalcaemia leads to enamel hypoplasia and poor mineralization of teeth which are predisposing factors to dental caries. In a study by Reed et al in 2020 suggest a possible correlation of maternal calcium status with tooth mineralization and development, they also suggest that children of mothers having normal blood calcium level had sound enamel, well mineralized teeth that can withstand dental caries.²⁰ In a study conducted by Reed S.G. Forrest et al in 2011, has concluded that calcium deficiency is cause of enamel hypoplasia and dental caries.

A study conducted by Mohsenipour et al 2017, in Iran have found that abnormalities relating to tooth development and calcification were seen in children suffering from hypocalcemia, their findings also coincides with our results.¹¹

A cross-sectional study performed in Canadian schools in 2015 by R.J. Schroth et al showed that hypovitaminosis D along with hypocalcemia is closely related with extensive dental caries.²⁵ The results of this study matches with our findings. A study held in

Table III: T test for calcium levels in group with caries and without caries

| Groups on the basis of Caries | N | Calcium level mg/dl Min. | Calcium Level mg/dl Max. | Mean | Std. Deviation | t test |
|-------------------------------|----|--------------------------|--------------------------|------|----------------|--------|
| Group no.1- Caries | 60 | 7.9 | 8.7 | 8.2 | 0.35 | 0.001 |
| Group no.2- No Caries | 20 | 8.7 | 10.5 | 9.75 | 0.52 | |

Table II: t test comparing vitamin d levels in caries and without caries groups

| Group on basis of Caries | N | Mean Vitamin D conc. (ng/ml) | Std. Deviation | Std. Error Mean | t test |
|--------------------------|----|------------------------------|----------------|-----------------|--------|
| No Caries | 20 | 47.2 | 14.0 | 3.14 | |
| Caries | 60 | 20.0 | 5.9 | 0.76 | 0.001 |

Table I: Correlation of Vitamin D, Calcium levels with Caries

| | Vit. D | Calcium | Caries | Significance |
|---------------|----------|----------|----------|--------------|
| Vit. D level | 1 | 0.946** | -0.890** | .000 |
| Calcium level | 0.946** | 1 | -0.827** | .000 |
| Caries level | -0.890** | -0.827** | 1 | .000 |

**Correlation is significant at the 0.01 level

Germany by Kühnisch et al. in 2015 suggested that higher serum vitamin D levels were linked with fewer chances of having extensive dental caries in permanent dentition, the results also support our study.²⁶

Poor oral hygiene, consumption of fizzy drinks are the predisposing factors causing dissolution of enamel layer which later on develops into dental caries. We cannot fully explain all the factors associated with dental caries

which exist with hypocalcemia. Advance research works are required to assist our findings.

Thus hypovitaminosis D and hypocalcemia at the time of tooth formation is the major element causing defective mineralization and enamel hypoplasia, which are major risk factors for dental caries. Children of developing countries like Pakistan are suffering from nutritional deficiencies, vitamin D and calcium are among one of them, which increases the chances of enamel hypoplasia and predisposes them to caries. Our study might be informative in providing bases for the prevalence of dental caries in our country.

There should be some educational symposiums so that our public should be made aware of healthy eating habits, in particular, calcium and vitamin D intake of our young children should be increased in the form of dairy products or supplementation so that general health of our population will be improved.²⁴ Serum vitamin D and calcium should be checked as a part children health promotion programs. In this way hypocalcemia can be prevented.

Improving the diet of children by including food rich in vitamin D and calcium may have valuable effects on overall health of the child and on dental health.

Conclusion

Our study concludes that normal vitamin D and calcium levels in children have a significant role in decreasing dental caries and also on tooth mineralization. It is therefore suggested that by improving children's vitamin D and calcium levels we can also have our population with better dentition and strong bones.

Disclosure:

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Authors Contribution:

^{1,3}Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work & Final approval of the version to be published

^{2,4,5} Drafting the work or revising it critically for important intellectual content;