RES MILITARIS
REVUE EUROPEENNE D ETUDES EUROPEAN JOURNAL OF MILITARY STUDIES
Social Science Journal

Radiographic presentation of nutritional deficiencies on morphology of tooth and pulp- Review

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Abstract

Malnutrition appears to have various impacts on oral tissues and the development of oral illness. It affects the growth of the dental structures and progresses the diseases related to oral or dental structures. Clinical history and oral examination are essential in diagnosing such conditions. Still, radiographs are equally essential to determine the specific extent of damage that nutritional deficiencies cause to enamel, dentin, pulp chamber, and surrounding alveolar bone, as well as many developmental disorders in which nutritional deficiencies affect the pre- and post-eruptive phases of developing teeth, resulting in characteristic radiographic anomalies.

Keywords: Nutritional Deficiency, Developmental Anomalies, Radiographs.

Introduction

The teeth are specialised elements of the human body whose growth is cryptic and difficult to comprehend. A complicated reciprocal connection between the dental epithelium and the underlying ectomesenchyme is required for tooth formation to be effective. A complex network of chemical signals, receptors, and transcription regulatory mechanisms is involved in the connection.[1]

Our food impacts the oral environment and dental tissues. It is well known that the quantity, as well as the quality of the food, the frequency of the food consumed, the type of the diet, the nutritional elements along with microbial flora- all have a part in the general health of oral cavity as well as that of the teeth. There is required literature supporting the specific role of the varied nutrients at the particular oral hard tissues development stages. However, the research is scarce regarding the specific impact of the deficiencies on the development of the oral hard tissues. [(2)]

Because of malnutrition, there is a broad range of impacts related to oral tissues, cavities, and oral diseases that may also aggravate due to malnutrition. The nutritional conditions impact the oral structure's growth and the oral disease progression by varying tissue homeostasis, reducing microbial biofilm resistance, and decreasing tissue healing capacity. Enamel hypoplasia has been linked to Vitamins like A & D and other nutritional element deficiencies like Protein Energy Malnutrition (PEM). These deficiencies are known to cause the atrophic degenerations of the salivary glands. The reduction in salivary production along with the deterioration of the quality of the saliva is known to lower the capacity of the oral cavity to protect itself from infection and buffer plaque acids.[3,4]

Clinical history and oral examination are essential in diagnosing such conditions. Still, radiographs are also crucial in determining the extent of damage caused by nutritional deficiencies on enamel, dentin, pulp chamber, and surrounding alveolar bone and many developmental disorders in which dietary deficiencies affect the pre-and post-eruptive phases of developing teeth, resulting in characteristic radiographic anomalies. There are a few instances where radiographic interpretations aid in better understanding the disorders impacting the tooth structure.

Abnormalities of the Crown

Dens invaginatus is a dental deformity caused by the "Infolding" caused during tooth development because of the dental papilla. One can broadly divide it into three categories which are based on radiographic interpretation of the degree of invagination by Oehlers as:

- Type I
- Type II
- Type III

Type I: Invagination won't extend beyond the Cementoenamel Junction (CEJ); only it is restricted to the tooth's crown.

Type II: Invagination extends under the CEJ junction and closes in a blind sac which may or may not communicate with adjacent pulp, which is adjacent to it.

Type III: Without instant communication with the pulp, invagination prolongs through the root perforates in the apical or lateral radicular area.

Dens Evaginatus resembles a cusp like the elevation of enamel in the central groove or rather a lingual ridge of a buccal cusp of a permanent molar or the premolar teeth. The occlusal surface appears tuberculated on radiographs, and a pulpal extension is frequently visible in the cusp.

Taurodontism is a morpho-anatomical shift in the morphology of a tooth where the tooth's body gets expanded, but the roots are shrunk. Radiographically, the defining characteristics consist of an expanded apical displacement of the pulpal floor and pulp chamber, with no narrowing at the level of the CEJ.

Abnormalities at the Root

An irregular bend or angulation in a tooth's root or, less commonly, its crown is known as Dilaceration. The aberrant angulation can occur anywhere along the tooth's length, and it can be detected with IOPA or by removing the tooth. Radiographs collected at various angulations are frequently required to detect and diagnose Dilaceration. The mesial or distal root curvatures of dilacerated roots can be seen clearly on periapical radiographs.

Defects in the Enamel

Enamel hypoplasia was also documented as a phenotypic trait in a family with recessive tooth agenesis. An underlying abnormality in the odontogenic epithelium or a failure in communication between the tissue layers might explain the co-occurrence of enamel hypoplasia and agenesis. Amelogenesis imperfecta (AI) causes a hypocalcified enamel layer, with pitting visible clinically and radiographically in certain instances and badly deformed enamel. During the radiographic examination, individuals with normal and reduced enamel thickness were found to have a similar frequency. However, for most AI patients, a reduction

in enamel radiopacity compared to dentin was a significant characteristic. Patients with hypoplastic AI had lower enamel thickness and radiopacity more frequently. The enamel bearing normal thickness and decreased radiopacity related to dentin is presented among patients with hypomature AI, and enamel with reduced thickness and radiopacity is seen among the patients with hypocalcified AI.

Defects in the Dentin

Dental Dysplasia: Baume et al., researched Polynesian school-aged children in 1966, 1968, and 1969 and discovered two forms of dental dysplasias. In the primary odontoblast-like condition, the two manifestations were in the permanent dentition 'yellow teeth'. He attributed these findings to a probable starvation status during the initial stages of life when the teeth were mineralizing and forming, which might have resulted in changes in enamel structure and morphology. At the apex, the roots may seem darker or radiolucent/pointy, short, and constricted.

Dentine is put down incorrectly, resulting in excessive development of the pulp chamber. It will diminish the pulp space in permanent teeth and eventually result in partial or total pulp chamber obliteration. On dental radiographs, teeth of coronal type exhibit normal roots with more significant pulp and atypical expansions towards the roots, commonly characterised as "thistle tube" shaped. Furthermore, aberrant calcifications may result in multiple pulp stones in the pulp chambers. The pulp chamber usually is obliterated in primary teeth, whereas the pulp chamber in permanent teeth may become partially obliterated after the eruption.

Vitamin A Deficiency- Vitamin A's impact on tooth formation is critical for tooth growth and maturation. The mineralization of the tooth and bone mineralization is dependent on Vitamin D, and when levels remain out of balance, it can lead to rachitic teeth. According to D'Ortenzio et al., this is a defective and hypo-mineralized organ that is very susceptible to degradation and fracture. On the IOPA and clinically, enamel hypoplasia-like signs might be noted.

Vitamin D Deficiency- In a healthy person, the pulp adopts the shape of an arch with two "horns" on top. The form of the pulp in someone with a Vitamin D deficit, on the other hand, is asymmetrical and compressed, resembling a side view of a hard-backed chair.

Discussion

Dental caries is the most prevalent disease, mainly seen in childhood worldwide, which commonly remains untreated. To treat any dental caries or periodontal disorders, accumulated evidence indicates that dental caries negatively affects children's nutritional status and growth. Malnutrition is a composite condition that can start early in life, such as during pregnancy or childhood, or develop at a late stage in life as a result of poor nutrition.[5] Among children, one of the leading causes of delay in tooth eruption and exfoliation and making deciduous teeth is malnutrition. According to three cross-sectional studies, this problem may cause a more vulnerable to caries attacks later in life.[6-8] Another retrospective cohort research discovered a link between tooth eruption and exfoliation patterns and the dietary deficiency (stunting) in childhood.

The eruption of the permanent teeth and exfoliation of the primary dentition were both delayed in this research.[9]

Various studies in India also detected a link between delayed tooth eruption and nutritional conditions, which is poor.[10] Based on those research findings, it is inferred that malnutrition caused tooth development to be delayed, changed the age distribution of dental caries, and resulted in an enhanced caries experience. The diet has a significant impact on periodontal tissue health. There is a link between calcium consumption and periodontal disease. Calcium remains essential for maintaining the density of the alveolar bone, which supports the teeth. Vitamin C and periodontal disorders have a similar association. (FIG 1&2)

Vitamin C is directly linked with periodontal health. The deficiency of Vitamin C leads to gingivitis and periodontitis. Notably, if a person has a reduced capacity for Vitamin C absorption, one will suffer from periodontitis. Rather than supplements, it is advisable that one obtains Vitamin C through the consumption of fruit and vegetables. Furthermore, Vitamin C has a vital role to play in slowing down the progression of diseases, and also in the prevention of some diseases.

Periodontitis is one such disease which is caused due to inflammation of the gingival tissues, and it can lead to complications such as diabetes and adverse outcomes in cases of pregnancy. Surveys found that almost 90% of the population suffers from periodontal diseases during their lifetime. There are also many studies on the preventive ability of Vitamin C in cases of people suffering from periodontitis. In contrast, these studies highlighted the direct relation between Vitamin C and periodontal health, especially in children.

Vitamin C acts as a scavenging agent to remove free radicals through anti-oxidation and as an enzyme cofactor in the cells. Indeed, Vitamin C slows the progression of periodontal disease by inducing differentiation of progenitor cells in the periodontal ligament. Further, the ability of Vitamin C to protect periodontal health is analysed by several clinical studies. All these studies have highlighted a direct relationship between positive periodontal health with increased blood Vitamin levels and increased dietary intake of Vitamin C. Hence, people suffering from malnutrition are more likely to have periodontal disease and complicated adverse outcomes. Further to the above, calcium also plays a vital role in people's oral and periodontal health.

Calcium is a nutrient critical for the teeth and bones of the human body. In cases of calcium deficiency, the calcium from bones of the body, including teeth, will be absorbed by the body for its function. Such issues lead to brittle teeth, increased risk of tooth decay and osteoporosis. One of the symptoms of calcium deficiency is that people start losing teeth and have weaker bones.

Several studies have highlighted a direct correlation between calcium deficiency and tooth loss. They found that people who did not take in enough calcium each day or faced malnutrition issues were much more likely to lose at least one tooth within two years of the onset of deficiency.

Calcium dietary intake has long been a reason researchers modulate periodontal disease. It is also linked to Vitamin D intake or deficiency. The results of studies found that there is a close association between less intake of dietary calcium in the periodontal disease, which was found for young males and females, i.e. in their age group from 20 to 39 years, and also for older males in the age group of 40 to 59 years of age.

Many surveys found that most global population has less calcium intake, and Vitamin D serum levels are below recommended values. Despite extensive evidence that optimal

calcium and Vitamin D intake does not only benefit people's postcranial bone health but can also have other health benefits.

Many research highlighted that deficiency of Vitamin D and calcium will result in bone loss and increased inflammation, which is the predominant symptom of periodontal disease. Researchers have suggested that calcium intake has been related to alveolar bone resorption for decades. In recent years, many researchers have recommended that Vitamin D and calcium potentially benefit periodontal health. It has also been suggested that any calcium deficiency is considered a risk factor for periodontal disease.

Due to the deficiency of Vitamin B, one might face the potential cause of irregularities in the oral structures. Decreased levels of Vitamin A are closely related to salivary gland atrophy. The PEM (Protein Energy Malnutrition) is associated with external structural defects, also called hypoplasia, which leads the oral cavities to more demineralisation. Many studies pointed out that the PEM, along with deficiencies of Vitamin D and Vitamin A in people, will lead to hypoplasia.

With all these above data, it is very clearly established that malnutrition will badly affect the oral health of the people, more effectively in kids and old people. Malnutrition, especially in younger people, can alter homeostasis, and this condition will lead to disease progression in the oral cavities. Further, such condition can also reduce the human body's resistance to the microbial biofilm and hence minimises the tissue healing capacity of the people. In kids, malnutrition can also affect the development of the oral cavity.

This malnutrition is a condition which can have early occurrence in childhood, thus resulting in individual's lifetime of poor oral and overall health. The complicated defects concerning oral health due to malnutrition include:

- Enamel hypoplasia;
- Eruption patterns of the tooth;
- The prevalence of dental caries;
- Periodontal ligament.

Further, it could also lead to inflammation of the oral cavity lining and tongue and can lead to oral ulcers.

Sweeney et al., discovered that linear hypoplasia of the primary maxillary incisors was linked to early-life viral episodes and low blood vitamin A levels in a research.[9,10] Infante and Gillespie found a substantial link between the degree of linear enamel hypoplasia and the presence of caries in the primary teeth of malnourished Guatemalan children. Many investigations have found a link between early childhood malnutrition and enamel hypoplasia in primary teeth using varied research methods.[11]

Conclusion

The trophic environment must offer nutrients to ensure that genetic information is expressed appropriately. The growth of oral tissues depends on this time of nutrition exchange. Nutritional sufficiency predominantly will be in the form of nutrients such as mineral components, Vitamin A and protein, which are critical for oral tissues both before and after birth.

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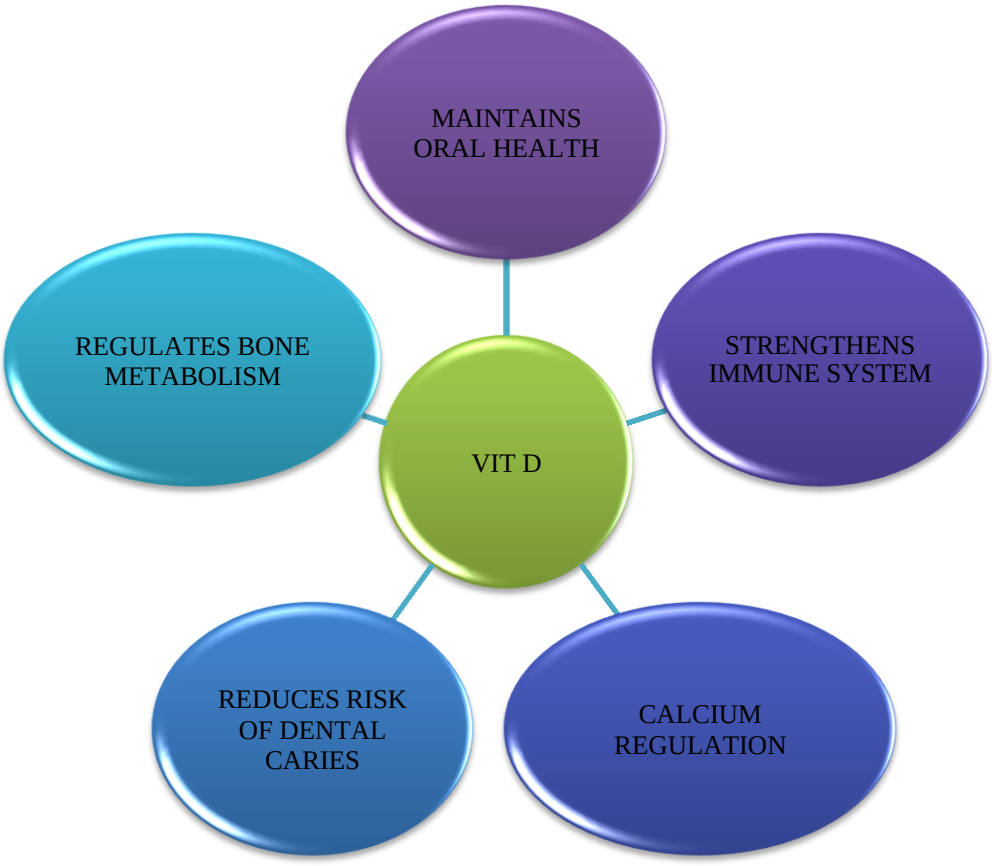

Fig 1: *Vit D and Oral Health*

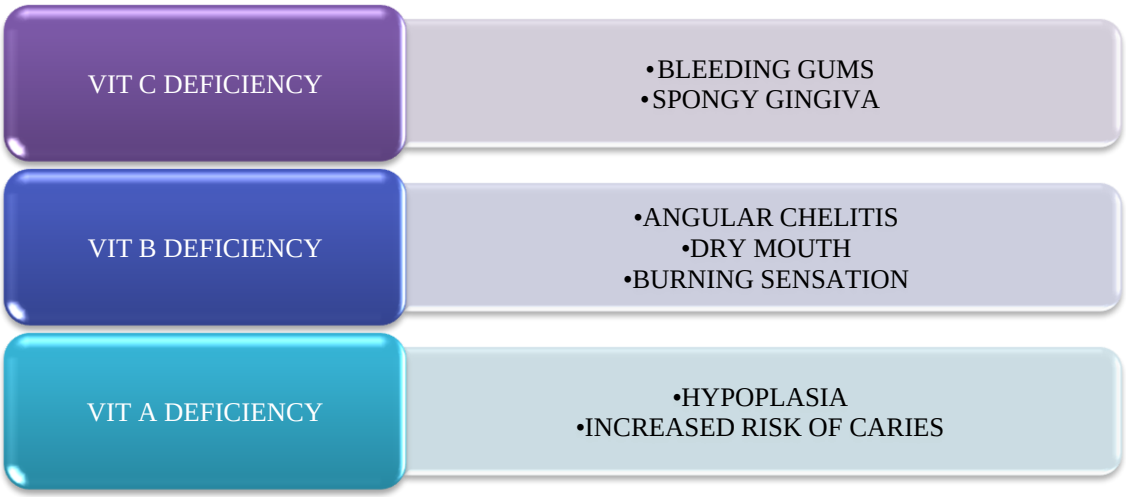

FIG 2: *Effect of Different Vitamins on Oral Health*