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Review article

Current Panorama of Dental Caries

Albino Campos Díaz[1], Quetzalcóatl Hurtado Sánchez[2], Julio Basilio Robles Navarro[2], Julieta Castillo Cadena[*2]

[1] Faculty of Medicine, Autonomous University of the State of Mexico, Mexico

[2] Research Center in Medical Sciences, Autonomous University of the State of Mexico. Jesús Carranza 205, Col. Universidad, Toluca, Mexico. 50130.

[*]Corresponding author: Julieta Castillo Cadena, Research Center in Medical Sciences, Autonomous University of the State of Mexico. Jesús Carranza 205, Col. Universidad, Toluca, Mexico. 50130, E-mail: jcastilloc@uaemex.mx

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Abstract

Dental caries is a dynamical, multifactorial, commonly chronical process that affects one or several zones on the tooth surface. In 2012, WHO reported that 60-90% of the children and almost 100% of the adults in the world had dental caries. In Mexico, the System of Epidemiological Monitoring of Oral Pathologies (2015) reported that in a number of states, 93.2% of the population had dental caries. This review stresses that at present, additional to the classic factors involved in the etiology of dental caries, the participation of socioeconomic, educational, physiological factors as well genetic predisposition are considered; also, its association with systemic diseases, type 2 diabetes, for example, and with serum levels of iron and ferritin in children. Regarding diagnosis, the determination of serum iron level is considered, as well as the use of Diagnodent and digital infrared transilluminator. For the treatment of dental caries, antimicrobial photodynamical therapy, ozone therapy and peptide *P11-4* are proposed. Nowadays, in order to prevent caries in child population, the application of the Basic Research Factors Questionnaire (BRFQ) is proposed. The possibility of decreasing the risk of developing caries from the sort of diet is being tried consulting an internet database created by expert dentists.

Keywords: dental caries, prevalence, diagnosis, prevention and treatment

Introduction

Dental caries is the localized destruction of dental tissue structures caused by acid byproducts from the bacterial fermentation of food carbohydrates. A chronical, preventable, cumulative disease, it is considered the main cause of toothache and tooth loss in its most advanced stages, whose sequels have long-term impacts [1, 2].

Among the most important etiologic factors traditionally involved in caries development, one finds microorganisms, mainly *Streptococcus,* with subspecies *S. mutans* and *S. sobrinus* [3]. In relation to diet, we consider the consistence, texture, adhesion and conditions in which sugary foods are eaten, as they are the most relevant owing to their cariogenic potential and pose a higher risk as they are consumed between meals.

The protective role of saliva depends on its quantity and quality that manage to dilute and wash sugars in daily diet, neutralizing and cushioning the acids in dental plaque, supplying ions for the remineralization process. For instance, *lactoferrin*, a glycoprotein present in saliva, inhibits microbial growth from the sequestering of iron. Iron-free *lactoferrin*, called *apolactoferrin*, has a bactericide effect against various bacterial strains, including *S. mutans* [4].

Dental anatomy and tooth occlusion are factors to consider, since they keep a close relation with caries development, as well as tooth abnormalities; for example, its shape and composition [5]. Time is decisive when the previously mentioned etiologic factors interact for long: demineralization and irreversible damage on enamel or dentin occur [1].

In 2012, World Health Organization, WHO, estimated that between 60 and 90% of the children and almost 100% of the adults in the world have dental caries. In Mexico, *Sistema de Vigilancia Epidemiológica de*

Patologías Bucales [System of Epidemiological Monitoring of Oral Pathologies] reported that in 2015 in various states of the country, 93.2% of the population had caries, not encouraging data, in spite of the efforts to prevent it [6,7].

The classic methodology to diagnose dental caries considers the use of a probe and a 1x4 exploration kit, this is to say, mouth mirror, reamer, explorer and pincers on the tooth's surface; also, the dentist can resort to imaging studies such as X-rays, in order to identify the carious lesion's destruction level.

For the primary prevention of caries, strategies and agents are utilized to prevent the beginning of the disease, for example fluoridation of drinking water, fluoridation campaigns and sealing pits and fissures in schoolchildren's teeth. Secondary prevention uses treatments to stop the pathological process and/or restoring the tissues as close to normality as possible, for instance with preventive resins. Tertiary prevention utilizes the necessary measures to substitute lost tissues and rehabilitate the patients' physical capacities as close to normality as possible, for example placing dental prostheses [8].

In virtue of the development of new drugs and materials with recent technology, the present work had as a goal to ascertain the current panorama of dental caries considering advances in the identification of etiologic factors, relations with other diseases, diagnosis, prevention and treatment.

Materials and Methods

The revision of the literature was supported on PUBMED and NCBI databases. Information was sought using the key words: *caries, diagnosis, prevention, treatment, family, national and international frequency.* The period from January 2012 to June 2017 was considered. Systematic reviews with or without meta-analysis were excluded.

Results

With the previously stated criteria, 27 articles were obtained, from which 11 describe etiologic factors of dental caries, 4 consider genetic factors, 3 refer to prevalence, 3 to current diagnosis methods, 3 to prevention and 4 to treatment.

Dental caries' etiology

Nowadays, adding to the aforementioned classic factors involved in the etiology of caries, there is information on other agents. Fort et al. identified the socioeconomic profiles of 12-year-old schoolchildren associated to frequency and severity of caries in Avellaneda, Buenos Aires. They observed that in localities with a profile of poverty and lack of social protection, in Dock Sud district, the prevalence and severity of caries in children is high. Similarly, in Africa, Jordan Cheng (2016) concludes that as the least privileged districts do not have an oral health professional, people resort to traditional healers and concludes that appropriate care is inexistent [2,9].

In India, Edat HR assessed maternal factors that may be an indication of the development of caries in children, among which one finds the demographic, dental plaque and the flow of saliva, and associated them with the caries index. The author found that the mothers' characteristics such as age, schooling and socioeconomic status associate with their children's caries index [10].

On the basis of recent information, Gutiérrez et al. consider that genetic predisposition and possibly epigenetic events are associated to the risk of developing caries. Individuals who display a lower tendency to caries regarding others in equal conditions have been observed [4]. Shaffer et al. identified the variants among the genes of men and women related with dental eruption, dietary habits, physiological functions in saliva and other risk factors for caries. They concluded there exist different effects by sex and they called them gene interactions by sex, this is to say, associated to sexual chromosomes [11]. In the United States, Lewis et al. associated the 28 variations of genes *MMP10, MMP14* and *MMP16* of metalloproteinases of the cell matrix, which degrade the extracellular proteins to the process of dental caries. They found that two variants of a single nucleotide (SNPs) of gene MMP16, which are *rs1046315* and *rs10429371*, significantly associate with dental caries in permanent dentitions of white adult males [12].

In India, Vidya et al. compared and contrasted the prevalence of caries and the various sensory levels for the taste of certain foods by means of gene *6-n-propylthiouracil* (PROP) and its variations, which is utilized as a tool to find out the sensitivity for sweet and sour tastes in mothers and children. They concluded there is no significant relation between the mother's sensitivity and that of her children. Moreover, they verify that the difference in oral health habits, eating patterns, amount of food and consumption frequency play an important role in caries predisposition [6, 13].

The contribution of the study of genetic predisposition to caries etiology has been tried in homozygote and dizygotic twins, on whom differences in the caries index has been observed in equality of conditions [4].

Wang et al. found by means of the Genome Wide Association Study that there is an association between the genes involved in the signaling pathway of MAPK as *RPS6KA2* and *PTK2B*, also genes *TLR2*, involved in the immune response, with caries (14). Shimizu et al. (2013) analyzed genotypes of Philippine families associated with caries in region *5q12.1-5q13.3*, and found out that gene *BTF3* of saliva is associated with the caries index. This gene codifies basic transcription factor 3, indispensable for the formation of the complex with RNA polymerase IIB to join the nuclear factor kB1, it also participates in processes of the cell cycle and apoptosis [15].

The variation of the factors inherent to the host, such as heritage, the altered immunological response to cariogenic microorganisms and their association with human leukocyte antigen have also been considered risk factors [11].

Caries prevalence

In India, Madhu et al. analyzed the prevalence and factors that produce early caries in 4-year-old children and concluded that being at nursery schools increases them [16]. If we refer to caries prevalence in teeth's specific places, in Saudi Arabia, Syed et al. (2017) studied 979 patients and found that caries frequency in the distal part of the second molars, owing to the third molars impacted, was 39% in men of 21-28 years of age, higher than in other age groups [17].

The prevalence of caries associated to systemic diseases has been recently documented. In India, Ekta et al. studied adults with type II diabetes, in the hospital of Ahmedabad, and found that it is significantly higher in comparison with healthy adults [18].

Data reported in studies in several states of Mexico are not encouraging. In a study performed in San Luis Potosi, in a group of students aged between 6 and 12 years, it was found that 85.6% had caries. The global Significant Caries Index was 4.65 in deciduous dentition and 5.45 in permanent teeth at six years of age [19]. Likewise, in an indigenous community in Oaxaca, 88% was reported for deciduous teeth and 71% for permanent. The index of decayed, missing, and filled teeth (DMFT) was 2.07, and the index of decayed, extracted and filled deciduous teeth (DEFT) was 5.4. The factors associated in this case to the phenomenon were mainly isolation, linked to the situation of poverty they live in, which prevents them from going to a dentist and negatively restricts their access to the information that may enable them to acquire the right habits to decrease this disease [20].

Caries and relation with other diseases

In India, Venkatesh et al. and, in China, Jianey et al. found an association between low serum levels of iron and ferritin with dental caries in 6-year-old children and adults with and without caries. They mention that dental caries can act as an early warning signal when there are low levels of iron and can make the patient receive the necessary interventions before the adverse aftermath of iron deficiency [21,22]. Chorzewski et al. defined the level of protection factors in saliva in patients with Diabetes mellitus Type II and found out that there is heavy influence from proteins in saliva on the prevalence and development of caries [23].

Caries diagnosis

At present, apart from the traditional clinical methods to diagnose caries, technology provides dentists with other reliable options. Sichani et al., Menem et al. and Lara-Capi et al. performed more sophisticated and dependable diagnostic tests to detect caries. They obtained favorable results when comparing them with the classic methodology, using laser fluorescence technology such as DIAGNODent, and digital transilluminator, which allow detecting caries in its initial phase and thus making minimally invasive interventions [24- 26].

Caries prevention

It has to be mentioned that preventive measures such as fluoride application, tooth brushing and dental care advice to prevent caries over a period of six months to a group of children demonstrated that money can be saved in the long term when comparing the cost of treatments for caries in the study carried out by O'Neill et al. in Northern Ireland [27].

Hayes et al. propose providing better oral health services by means of online dental advice to assess diet vs the risk of developing caries. This will improve dental practice in the provision of diet advice, positively impacting the patients' behavior to change their eating habits [28].

Dental caries is a disease with a great impact on children's health and produces heavy expenses on health care services. It has been demonstrated that oral health programs for children implemented in various parts of the world are efficacious to prevent dental caries. In Singapore, Lai et al. examined the clinical efficiency of an oral health program for infants and toddlers, which helped reduce early severe caries [29]. Albino et al. describe the implementation of a questionnaire produced by the National Institute of Dental and Craniofacial Research, Colorado, U.S., called the Basic Research Factors Questionnaire for Studying Early Childhood Caries (BRFQ), whose goal is to develop standard measures of factors implied in early childhood caries and has the potential to improve the capacity to understand the underlying mechanisms for successful prevention and develop more effective interventions [30].

Treatment of caries

Ornellas et al. describe the use of antimicrobial photodynamic therapy for caries treatment. It implies the activation of a photosensitizer by a visible light source to induce chemical reactions that produce cytotoxic reactive oxygen species, induce oxidative stress and result in the inactivation of pathogen microorganisms. They report the results of this therapy in a molar with deep caries in a 7-year-old boy, where the pulp vitality was preserved with a minimal intervention in short time [31].

For their part, Makeeva et al. analyze the efficacy of ozone in cariogenic microorganisms and significantly surpasses the efficacy of hydrogen peroxide at 3%. On the basis of their results, they suggest the convenience of including ozone in the protocol of noninvasive treatment of initial dental caries [32]. Schlee et al. also analyzed clinical therapy with peptide P11-4 in 28 patients with non-cavitated initial caries. Twelve months after treatment, they showed regression changes of the initial lesions in 17 out of 28 cases [33]. In this line, Cummins D also developed a new technology based on arginine at 1.5%, a compound of insoluble calcium and fluoride for daily use to prevent and treat dental caries. It is a new dentifrice, which combines arginine and fluoride, clinically tried that offers better protection against caries (34).

Conclusions

In addition to the classic etiological factors involved in caries, nowadays genetic factors and possibly epigenetic events are included. The variants between sexual chromosomes in men and women relate with dental eruption and the physiological functions of saliva come into play as risk factors for caries. Moreover, the variants of genes MMP16, rs1046315 and rs10429371, associate with the development of caries in permanent dentition in white adults.

The variations of genes *RPS6KA2, PTK2B* and *TLR2*, which participate in the immune response, and also gene *BTF3* of saliva are associated with a high caries index; adding to sociodemographic profile, social protection and maternal characteristics such as age and schooling.

The high prevalence at national and global level is the proof that there are multiple factors involved in caries, as previously described. For the prevalence associated with other factors, we can mention that it is higher in adults with type II diabetes and also in the distal face of second molars.

The use of DIAGNODent and transilluminator, products of new technology, offers an accurate and quick diagnosis. Photodynamic therapy with ozone and peptide P11-4 offers conservative treatments for the patient's wellbeing. Regarding caries prevention, there is an alternative in the online advice for mothers and children by expert dentists and the application of BRFQ for a successful prevention of the disease.

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