NEW DATA ON CLINICAL AND THERAPEUTIC MANAGEMENT OF OCCLUSAL CARIES. (I)

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Abstract

Dental caries is a transmissible pathologic infectious process in which a cariogenic biofilm, in the presence of a more pathological than protective oral status leads to demineralization of the hard dental tissues. The occlusal surface of posterior teeth represents, due to its anatomy, the most exposed place to dental caries. Even if the global ratio of such disease decreased in industrialized countries, the situation is different for occlusal caries. Nowadays, one of the main reasons for a lower ratio in the control of occlusal caries is represented by the fact that, in the so-called “post-fluorization” generation, fluoride has better controlled the caries from the smooth than from the occlusal surfaces. The term of fissural caries has been previously employed for describing the carious lesions occurring in pits and fossae. The definition was based on the assumption that the high incidence of carious lesions in the pits and fossae of molars was directly related to the low accessibility of these zones to the usual hygiene measures. Two factors are evaluated as to plaque accumulation and caries initiation on occlusal surfaces: the stage of dental eruption or the functional utilization of the occlusal surface and the specific surface anatomy. The scope of this review study is to synthesize the existing knowledge on the evolution of occlusal caries and the available methods of control and treatment.

Keywords: dental caries, occlusal surface, bacterial film, de- and remineralization.

1. INTRODUCTION

Carious disease, one of the pathologies determined by the combined manifestation of some genes, infectious or environmental factors and risky behaviours, is a complex one. Dental caries is an infectious pathologic process, in which a cariogenic biofilm, in the presence of a more pathologic than protective oral status, leads to demineralization of the hard dental tissues [1]. Dental caries is considered a multifactorial disease, which affects a large part of the population of the globe, continuing to represent the main cause of pain in the oral area and of tooth loss [2].

The occlusal surface of the posterior teeth represents, due to its anatomy, the most vulnerable place for dental caries onset. The scope of this review study is to synthesize the existing knowledge regarding the evolution of occlusal caries, the control and treatment options.

In the last decades, several reports, issued in various parts of the world, have agreed that the carious disease recorded a significant decline. The community of dentists outlines the efforts made to reduce the prevalence of dental caries by systemic or local use of fluoride, tooth pastes or sealers, together with advices regarding the diet, dental hygiene and higher level of dental services [3].

Even if the global prevalence of caries disease decreased in industrialized countries, the situation is different for occlusal caries. Nowadays, one of the main reasons for the low efficiency in the control of occlusal caries is the fact that, in the so-called “post-fluorization” generation, fluoride had had a better control on caries occurring on smooth surfaces, than on occlusal ones. This fact modified the epidemiological aspects, the higher number of primary lesions present on occlusal surfaces being now recognized and accepted. This calls for a permanent implementation of efficient
programs for controlling carious lesions in the pits and fissures of first permanent molars [4, 5].

2. EPIDEMIOLOGICAL DATA

Carious disease was and still remains a major problem of public health in most countries of the world, affecting 60-90% of school children, as well as numerous adult and old people. At present, the distribution and severity of dental caries varies in different regions of the world and even within the same region or country. According to the OMS Global Data Base on Oral Health, the global index of caries in 12 year-old children is of 1.7, yet significant differences in severity are recorded in various areas of the globe. At the same age, the level of caries lesions is relatively high in America and Europe, while lower levels are recorded in the children of Africa and West Pacific, and mean values characterize countries of South Asia and East of Mediterranea Sea (Near East).

The same data base provides information on the evolution tendency of caries experience in children. In most of the countries with low and average national income, the level of caries disease was low until recently, however, with the modification of the life style, with the dramatic increase of sugar consumption, with the insufficient exposure to fluoride, along with the absence of national programs for the prevention of oral diseases, the prevalence and severity of the disease registered a rapid growing tendency.

In contrast with this, in the last 20 years, a decrease in caries prevalence was recorded in most of the countries characterized by a high income. This evolutive pattern is a consequence of the efficient measures taken to ensure public health status, such as: use of fluoride, improved living conditions, optimum level of information, a correct application of the measures for oral hygiene and the introduction in schools of programs for prevention and maintenance of the oral health [6].

An acute need for the implementation of preventive attitudes to reduce the carious disease is manifested, once the efficiency of the preventive methods has been demonstrated clinically and scientifically in several countries. However, not all countries have implemented such public health programs, so that a large part of the population still requires restorative procedures with moderate prognosis in time, ending with edentation. In the developing countries, only a small part of the population is oriented towards programs for oral diseases prevention, while the medical services settle exclusively the emergencies, only to release the pain. Such services involve, in most of the cases, extraction, the simplest and cheapest form of treatment [7, 8].

In spite of the success assured by preventive attitudes, restoration of carious teeth still remains a must. Even if the restorative procedures are more and more available, more modernized and more technologized, the higher prevalence of caries in the developing countries will implicitly increase the number of edentulous persons.

The explosive increase of caries prevalence in the XIXth century, especially in economically advanced countries and among the rich classes, led to a rapid evolution of restorative therapy and of the surgical treatment in the dental tissues affected by carious lesion. Restorative attitudes continue the basic approach in the management strategies of this disease, along with the contribution of the systems of cost repayment [9].

In the XXth century, scientific proofs evidenced the shortcomings of a position oriented exclusively towards restaurative attitudes, encouraging the therapeutic strategies based on cariogenic risk, which control the carious disease by preventing its installation, by reversing the precocious caries signs and by maintaining the dental structure. However, such approaches have not been universally adopted, as the education, the crediting system, license obtaining, the dental practice, as well as the reimbursement systems of most of the countries have to take into consideration the number and complexity of restorative procedures. More than that, unhappily and paradoxically, the success of primary prevention, through water fluoridation, by using tooth pastes or other products that contain fluorides and reduction of the prevalence and severity of carious disease in the most of the developed countries led to an implicit consent on the questionable efficiency of the medical or biological management pattern of the carious disease. Success in caries prevention at
populational level influenced certain politicians, who drew the incorrect conclusion that the carious disease is under control, being less problematic than some decades ago. However, in the USA, the total cost of the treatment for the carious disease amounts annually to 60 millions $, on leaving aside lowering of life quality, the impact upon morbidity and mortality and the challenges represented by children and by the populational groups with no access to stomatological services [10].

Apparently, the new instruments for caries detection prior to become cavitary, applied without an adequate instruction, may lead to overtreatment, once known that operative/restaurative models, with new instruments, do not change the initial preventive/therapeutical strategy, which involves remineralizing technologies and less invasive procedures. Concentration on the restorative component in the management of the carious disease discourages the research in the field of the new remineralization techniques, as well as the utilization of the already known ones [11].

3. ETIOPATHOGENIC PECULIARITIES OF OCCLUSAL CARIES

Dental caries is an infectious, multifactorial disease, resulted basically from the complex interaction between the oral cariogenic flora (the cariogenic biofilm) and the easily fermentable carbohydrates resulted from alimentation, developed in time and first manifested on the enamel surface. According to the original diagram of Keyes-Jordan, caries etiology includes the 3 above-mentioned elements: the tooth, the bacteria and the hard dental tissue, yet it is undoubtful that involved in the carious process also present are certain modulating risk factors, and some protective ones, as well, which can explain the different carious susceptibility [4].

Caries lesion is a dynamic, reversible, incidental and asynchronous phenomenon occurring a few times a day, along the whole life, being modulated by factors such as the amount and composition of the bacterial biofilm, alimentation, oral hygiene, genetics, dental anatomy, availability of fluorine and of other chemotherapeutical agents, the salivary flow and the buffer capacity of saliva, as well as the different resistance of the hard dental tissue to cariogenic attacks.

The occurrence of de- and remineralization results from the unbalance between the pathological factors which favor demineralization: the acidogenic and aciduric bacteria, an altered salivary function, cariogenic alimentation, deficitary oral hygiene and the protective factors, namely the ones favoring remineralization: a correct salivary function, the availability of some remineralizing (fluoride, calcium, phosphate) or antibacterial (fluoride, chlorhexidine, xylitol) products, a suitable oral hygiene. The individuals whose balance is mainly influenced by the preponderance of protective factors are less susceptible to the occurrence of new carious lesions, comparatively with those in whom the pathological factors are prevailing. The clinical and therapeutical management of the carious disease is basically supported by the relation between the 2 classes of factors responsible for de- and remineralization [12].

As known, dental caries on the first permanent molar (M1) causes a large range of problems, on both short and long term. For several reasons, M1 is a “critical” tooth, as it is the first one to participate to mastication, its loss having negative effects upon the functional efficiency and integrity of the arch. If lost at young ages, the dento-alveolar congruence disappears, the bone gets resorbed, and the homeostasis of the stomatognate system is also lost [13]. What makes the M1 the most affected tooth by the carious process is the long eruption period, ranging between 12 and 18 months, when the occlusion plane is reached and it becomes fully functional. One should not forget that, for premolars, such a difficult period is of only 3-6 months. Along this time, the occlusal surface is not sufficiently hygienized, which is a result of the “incapacity” of the tooth brush to contact it, the bristles not exceeding the occlusal surface of the temporary molar. As a consequence, the occlusal surface will be covered by a bacterial biofilm and by alimentary rests, in a medium with a permanently acid pH. In this way, the tooth gets decayed as early as the time of eruption. Toothbrush alone can not control the whole carious process, as
the bristles are too large for cleaning the entrance in the very narrow fissures [14].

In the beginning, the term of fissural caries has been utilized to describe the carious lesions in pits and fissures. The definition was based on the assumption that the high incidence of carious lesions in the fissures and pits of molars was directly related with the reduced access to such area of usual hygienic methods. The occlusal fissures and pits vary as to their shape, however they are generally narrow (0.1 mm), evidencing irregularities which mechanically retain bacteria and food. Saliva cannot reach their bottom, which results in an incorrectly and insufficiently hygienized area. Being too large, the bristles of the tooth brush (0.2 mm) cannot penetrate the fissures [15]. The thickness of the enamel at the basis of fissures is minimum and, in numerous cases, they are extended practically into dentin [16].

The existing knowledge indicates that the narrow fissures in young permanent molars are not per se the place where the caries initiates. Two factors are evaluated as to plaque accumulation and caries initiation on the occlusal surfaces: the stage of dental eruption or the functional utilization of the occlusal surface and the specific surface anatomy. A carious lesion begins as a local process, occurring at the entrance of the deep fissures, in parallels with biofilm accumulation along the cusp slopes from the occlusal surfaces [17]. Such places offer protection against physical wear, favoring the formation of microcavities which provide the conditions for local bacteria, while the deeper zones of the fissure usually offer retention for non-vital bacteria. The growth and proliferation of bacteria accelerate demineralization and destroy the occlusal surfaces [18].

Frequently, such zones become "retentive", due to the de- and remineralization processes, permitting their clinical identification. That is why, the more correct term of "occlusal caries" is suggested for the conventional caries occurring in fissures and pits.

The pits and fissures present on the occlusal surface have an complex and irregular anatomy. Their depth varies, while their basis may take the shape of a superficial and narrow groove which can penetrate the enamel completely; the end of

The complex occlusal fissure system does not cause the caries by itself, permitting the access of microorganisms and of food in this wet, "protected incubator", characterized by a constant temperature, appearing as a real sanctuary favoring the development of a bacterial biofilm with a common cariogenic aciduric and acidogenic climate [19].

The grooves and pits evidence different tridimensional aspects in section, described according to the alphabetical order of their shape. Four types of fissural anatomy have been identified, as follows: type V and type U, with an entrance slit at least equal with the width of the basis, self-cleaned and, to a certain extent, more resistant to cariogenic attack; type I: virtually impossible to be cleaned with a toothbrush, so that it induces a considerable caries risk; type K, shaped as a "bottle neck" or as a "clepsydra": narrower at its entrance and with a wider basis, much more susceptible to caries – this type may also have branches, also highly susceptible to caries, actually representing the most susceptible type to caries onset.

The caries initiated in grooves and pits develop in the direction of the enamel prisms and form a specific lesion in the shape of a triangle or cone with its peak towards the surface and the basis towards the enamel dentine junction. As the evolution of lesions occurs at once on both or even all slopes of a groove or fissure, the global form of an occlusal carious lesion will be a triangle with the basis towards the opening of the fissure and its peak towards the enamel/dentine junction. Through destruction of the undermined enamel margins, the cavitated occlusal caries led to substance loss, which is more important than the lesions on the smooth surfaces [20].

Traditionally, the occlusal surfaces were considered susceptible to cariogenic attack as a result of their incomplete post-eruptive maturation, namely of the reduced mineral content of enamel, and of the presence of narrow and deep fissures occurring at this level, which shelter the bacteria responsible for the initiation of carious processes [19]. To demonstrate and update these two hypotheses, two questions
have to be answered: 1. which argument supports the concept of incomplete post-eruptive maturation? and 2. which is the role of the deep and narrow fissures in the evolution of occlusal caries?

To answer the first question, one should mention that such a hypothesis is substantiated, on one side, on the observation related to the porosity identified on the erupting teeth and, on the other, on the identification of a higher fluoride concentration on the tooth surface after the eruption. Analogically, it has been suggested that the enamel supports a post-eruptive maturation period after the eruption. Up to now, the mechanism of action during the maturation process mediated by the conditions assured by a neutral pH has not been elucidated, especially the manner in which fluoride might be incorporated into the enamel. As a matter of fact, its is quite improbable to accept that a maturation process, in its traditional meaning, might occur. A more logical explanation is that, during the eruption period, the enamel surface is subjected to several de- and remineralization cycles, whereas the fluoride present in the oral cavity leads to the increase of fluoride concentration in the most external layers of the enamel. When the enamel is exposed to low concentrations of fluorine ions, in an acid medium, fluorapatite is formed as part of the enamel. One should not forget, however, that the total substitution of the hydroxyl ions by fluorine ions on the enamel surface is limited, so that the fluorine from the enamel plays a minor role in reducing the dental caries.

Usually, when a tooth erupts in the oral cavity, the enamel is fully mineralized. Some tooth ratio may evidence qualitative and/or quantitative hypomineralizations, for example non-fluorotic, fluorotic opacities and hypoplasia. The non-fluorotic and fluorotic opacities are not associated with increased cariogenic risk. Hypoplasia may raise questions related to caries risk, sensitivity, necessity of certain restorations and aesthetic aspect. Nevertheless, a large number of populational studies demonstrated that the prevalence of molar-incisor hypomineralization in permanent dentition was of only 8.7% in children and of 5.4%, respectively, at tooth level. Considering all these aspects, an early occurrence of caries on the occlusal surfaces and their high prevalence should not be explained by the fact that the eruptive teeth are immature and, consequently, more exposed to carious processes [21].

The answer to the second question starts from the observation that, for having a cariogenic dental biofilm, namely for producing sufficient amounts of organic acids capable of dissolving the enamel, a protective environment is necessary. In the oral cavity, the protective media occur in the so-called ”stagnation areas”, such as the cervical third of the smooth and proximal surfaces, and the occlusal surfaces. These stagnation areas are protected by the oral mechanical functions, which involve mastication and movements of the muscles of the tongue, lips and cheeks, as well as of those involved in the swallowing reflex [22]. On the occlusal surfaces, special attention was paid to biofilm stagnation in the fissure-like structures and to the possible events produced in their deepest areas.

Few studies have investigated the contribution of the macromorphology of the complex fissural occlusal system (SFO) to the development of occlusal caries [23, 24]. This system is defined as a mechanism which connects each groove, fissure and pit from the occlusal surface. A pit is the depression present on the occlusal surface where two or more grooves meet. An ”intercuspal groove” is the one situated between two or more cusps, while an ”intersegmental groove” is localized between two parts of the same cusp. Together, the intercuspal and intersegmental pits and grooves form the ”anatomic centers” of the complex fissural occlusal system. These fundamental macroscopic units are considered positive structures which can equally show negative structures with a fissure-like morphology. The intercuspal groove with equal or less than 25° structural angles are considered to have a fissure-like morphology. The term ”narrow and inaccessible fissures” may be replaced by ”fissure-like” structures, as well.

To explore the natural inter-relation between the level of tooth wear and occlusal caries, teeth with extended wear surfaces, and rare and dispersed bacterial deposits and less worn teeth with different levels of ”undisturbed” microbial deposits and with carious lesions have been examined [25]. The teeth were cut and the
obtained sections were analyzed with a polarized light microscope. The teeth from the group with a high occlusal wear and rare deposits evidenced different stages of arrested occlusal caries lesions, whichever the depth of the fissure-like structures. The anatomic centers of SFO, associated with the lesions having arrested evolution showed a fissure-like structure, being, in most of the cases, completely filled with calculus. The combined clinical and microscopic examination of the teeth with minimum wear, with undisturbed microbial deposits and of the carious lesions evidenced that enamel destruction has been always related with the deepest part or with the most protected parts of the surface profile.

More than that, ultrastructural studies [26, 27] indicated that the bacteria present in the deepest zones of the fissure-like structures were not viable or were even calcified while, at the entrance in these fissures, the bacteria evidenced an intense metabolic activity, characterized by multiple cell divisions with morphologically intact microorganisms. Apart from this, it has been demonstrated that the intercuspal grooves with fissure-like aspect were not more carious susceptible than the intercuspal grooves with a typical "groove" aspect. These results indicated that it is the macromorphology of the occlusal surface and not the fissure-like structures per se that exercised a major influence on plaque accumulation and, further on, on enamel demineralization.

In this way, an early initiation and the high prevalence of occlusal caries in the young permanent teeth might not be explained through an inherently low, specific resistance of the occlusal surface, nor by the presence of inaccessible fissure-like structures [19].

The difference between the accumulation of bacterial biofilm on M1 during the eruption at the age of 6 years, and the wholly erupted molars at the age of 12 was significant, being accompanied by a considerable reduction of the thick plaque in the last stage [19, 26]. The same pattern was observed when the biofilm scores of M1 in complete eruption were compared with those of the permanent second molar (M2). Finally, the permanent M1 and M 2, in complete occlusion, demonstrated a limited accumulation of thin biofilm on the occlusal surfaces at the age of 15 years [26].

It has been thus demonstrated that the pattern of biofilm accumulation and its distribution on the occlusal surfaces were modulated by the stage of tooth eruption. On the other hand, formation and distribution of a thick biofilm on the proximal, smooth, free surfaces showed no modification induced by the eruption stage of the respective tooth.

Strong evidences demonstrated that the most important biological determining elements in the activity or inactivity of occlusal caries were the accumulation of a thick biofilm in the complex SFO and the eruption stage of the tooth which limits the oral mechanical functions [19].

4. CONCLUSIONS

The carious disease was and still remains a major problem of public health in most of the countries of the world, affecting more than half of the school children, as well as numerous adult and old people.

The existing knowledge indicates that the narrow fissures produced in young permanent molars are not per se the place where the caries initiates. Two factors are evaluated as to plaque accumulation and caries initiation on the occlusal surfaces: the stage of dental eruption or the functional use of occlusal surface and the specific surface anatomy.

Special attention should be paid, on the occlusal surfaces, to biofilm stagnation in the fissure-like structures of the complex occlusal fissural system and to the possible events produced in their deepest areas.

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