CAMBRA: Is there more to this?

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Abstract

Traditionally dental caries has been seen as a loss of mineralized tooth structure caused by a pathogenic bacterial infection by the tooth's natural biofilm. Major efforts have been made to protect the tooth with fluorides, sealants, and plaque removal. This traditional view is evolving from a local bacteriological disease to a systemic dietary disease caused by excess sugar consumption with dental caries as a sign and biofilm as a mediator that excretes acid, rather than biofilm as a primary cause. Other dietary diseases with signs and symptoms that result from excess sugar consumption are: overweight/underweight, obesity, diabetes type 2, CVD, gout, periodontal diseases, and others.

Introduction

It is the intention of this article to refocus attention to a larger view that dental caries is part of a constellation of diseases, signs and symptoms that are sugar ingestion related and that for our better general health as well as dental health, efforts should be made to seriously reduce intake of sugar and refined carbohydrates.

Brief History of Prediction of Dental Caries

Dental caries is a multifactorial disease [1] and this characteristic has hindered the relative importance and perspective of these components, e.g. is this disease a bacterial infection or a dietary disease that uses bacteria to produce acids which act as a transmitter to cause the disease. It makes a difference in the approach that is used for research and clinical care. If the caries is a dietary disease then there can be times and places where dental caries is minimal or non-existent in the presence of biofilm and this has been found, [2] when the diet was changed to include sugar, caries emerged [2,3]. Thus, the relative importance of the diet to the bacterial component can be appreciated. Interestingly, when assessing caries risk in patients, diet is always mentioned and mostly ignored in patient treatment and dietary counseling is not done, especially for total health. Since diet is not given a proper perspective, it is not surprising that prediction models for caries have limited success, except for the single predictor of past dental caries, which is probably diet related.

Assessing Caries Risk

Fontana and Zero stated that a comprehensive caries assessment should consider factors such as past and current caries experience, diet, fluoride exposure, presence of cariogenic bacteria, salivary status, general medical history, behavioral factors and physical factors, and medical and demographic characteristics that may affect caries development [4].

Celik et al. found that diet frequency, plaque amount and secretion rate were significantly associated with caries increment, [5] while diet frequency [5,6] is part of the Cariogram model, additional components such as plaque amount and secretion rate [7,8] are added. These additional factors may provide some usefulness; however, they detract from overall effectiveness.

The accuracy of the Cariogram model was questioned by Utreja et al. for predicting the occurrence of caries is in first permanent molars.

It was found to have a diagnostic accuracy of 63.3%, thus emphasizing the need for better prediction models [9]. The most recent available study [10] indicated that the Cariogram performed better than a caries risk assessment scheme based on past caries experience and caries progression, over a 3-year period in young adults.

However, Zukanovic evaluated three different multifactor caries risk assessment models (Cariogram, PreViser and CAT) showed that only the Cariogram can successfully predict new caries development in 12 year Bosnian children [11]. Multiple-variable logistic regression models of caries progression toward cavitation included family experience, transmission-related behaviors, dietary factors, health beliefs, and lower income, but differed in selection predictors/predictive power by race/ethnicity. Addition of clinical variables did not significantly improve the prediction [12].

Carson did a systematic review and suggests that evidence available on the validity of a number of existing systems for caries risk assessment is limited and weak [13]. Others have studied risk assessment sensitivity and specificity as well [14-17].

This illustrates the point of too many variables that are examined, and the primary variable (diet) is limited in the assessment. Others have examined CAMBRA and found that there is better sensitivity/specificity. Reasoning-based programs (CAT and CAMBRA screening) had high sensitivity ($\geq$93.8%) but low specificity ($\leq$43.5%) in predicting caries in children. CAMBRA's comprehensive assessment, reached a better balance (sensitivity/specificity of 83.7%/62.9%) [18].

However, because the modern diet has many components of processed food, it is difficult to study. In a six-year retrospective study of 12,954 patients, diet measured with a metric of frequent snacking had an odds ratio to caries risk of 1.77, but was not an overwhelming component [19].

Population studies show that when sugar is minimal or absent, caries is minimal or absent. The changes in diet of the hunter-gathered, approximately 10,000 years ago, to agricultural times has been found to be a greater reliance on starchy foods as the dietary staple, with resulting diseases of tooth decay, malnutrition, increased rates of infection, osteoporosis and anemia [20].

On the other hand when sugar was removed from the diet in large population groups during war time, caries prevalence among children decreased [21].

Single Predictor

Baseline caries prevalence was the most accurate single predictor of caries risk in all age groups [21-25].

This is significant as it gives insight into the major component of the multifactorial process of caries, namely sugar ingestion, which is particularly difficult to control and will be shown to be related to systemic disease. It is a fact that there are many factors involved in dental caries, however, when examining the three major factors of tooth, bacteria and diet, the question, is how is this to be viewed? Is dental caries a bacterial infection or a sign of a systemic disease using bacteria to produce acidic effects on tooth structure. It is a case of a new perspective.

What is CAMBRA?

CAMBRA is an acronym for Caries Management By Risk Assessment. The World Congress of Minimally Invasive Dentistry states that the latest research shows that caries is a pathogenic bacterial infection of the tooth's natural biofilm and is a multifactorial disease [26]. The traditional view has limited the development of better health by reducing or ignoring the importance of diet in the caries process.

Ramos-Gomez et al. stated that caries risk, include the following [27]:

Frequency of periodic examination

Frequency of radiographs

Saliva testing

Fluoride utilization

Xylitol products

Sealants

Antibacterials

Anticipatory guidance/counseling

Self-management goals

White spot pre-cavitated lesion management

Restoration/existing lesions

Notice that the primary factor in caries development is diet which is minimized under guidance and counseling, when it should be at the top of list for both dental health and general health.

Why it Does Not Work

There are some exceptions to the failure to control caries with fluorides and sealants, while ignoring diet counseling, e.g., Swedish school program.

The effect of the program is evaluated once every year on almost 100% of all 3-19 year olds in a computer-aided epidemiological program from 1979. Most of the individualized preventive program was done by dental hygienists or prophylaxis dental assistants at clinic in the elementary schools. Caries incidence was reduced more than 90% in all age groups [28].

However, the rule is that diet is important in caries risk assessment and prevention which must be diet counseling.

Sugar consumption in the US is both sucrose and High Fructose Corn Syrup (HFCS) based, with both being consumed in excess. It is seductive to want to blame the high consumption of HFCS particularly in Sugar Sweetened Beverage (SSB) on the increase in caries incidence, however, in a study examining that question: Results show that there was a statistically significant (P<0.05) difference between the pH values of plaque at different intervals of time with sucrose, fructose and glucose solution rinse in children with moderate caries, rampant caries as compared to the caries free group. Sucrose was found to be highly cariogenic in all the children with a greater potentiating effect in moderate and rampant caries. Glucose also appeared to have a cariogenic role, while fructose had the least of it all [29].

Rugg-Gunn stated, only three approaches are of practical importance to prevent caries: sugar control, fluoride, and fissure sealing. The evidence that dietary sugars are the main cause of dental caries comes from six types of study. Without sugar, caries would be negligible [30]. That raises the question of what could reasonably be assumed as an optimal amount of sugar consumed by the population.

Sheiham and James examined the relation between sugars and caries over a lifetime to determine if 10% level is optimum and compatible with low levels of caries for children and adults. They found a robust log-linear relationship to sugar intakes for 0% to 10% sugar with a 10 fold increase in caries if caries is assessed over several years' exposure to sugar rather than only for the first year after tooth eruption. A 10% E sugar intake induces a costly burden of caries. These findings imply that public health goals to set sugar intakes ideally <3% with <5% as a pragmatic goal, even when fluoride is used. Adult as well as children's caries burden should define the new criteria for developing goals for sugar intake [20]. However, this study concluded that while there appeared to be a relationship, the quality of evidence was very poor [31]. Others do not want think in terms of sugar and diet, and try to shift the paradigm to a behavioral disease.

The concern about the definition of dental caries is related to the method of prevention and restoration. Frencken et al. stated that the chance for Minimal Intervention Dentistry (MID) to be successful is thought to be increased tremendously, if dental caries is not considered an infectious disease, but instead a behavioral disease with a bacterial component [32].

Unfortunately many serious researchers have been misled in their approach to studying dental caries by the NIDR. This may explain the confusion about sugar ad diet in its importance to the caries process. A new report published in PLOS Medicine reveals that the sugar industry greatly influenced the U.S. National Institute of Dental Research (NIDR) 1971 research by shifting the group's focus away from dietary changes. This has resulted in 40 years of misdirection of dental research and the dental and general health of the US population [33].

This behavioral component could be the ingestion of sugar as well as preventive care. Prevention (fluorides and sealants) have a limited success in overwhelming sugar ingestion. Additionally, dental caries is a sign of dietary behavior of sugar ingestion that biofilm used to release demineralizing acids to cause destruction of tooth structure, periodontal diseases [1] and system diseases of excess sugar ingestion such as overweight, obesity, CVD, kidney, etc [34].

No Caries and General Health

Instead of studying the disease(s) related to decay, Price decided that if he wanted to know about health, he should go to areas of the world where health existed and dental decay and other degenerative diseases did not exist or were in minimal amounts. He traveled for 10 years making observations and took over 15,000 photographs. He investigated 14 remote areas in the world, including: isolated Swiss villages, remote island of the coast of Scotland, studied traditional Eskimos, Indian tribes in Canada and the Florida Everglades, South sea islanders, Aborigines in Australia, Maoris in New Zealand, Peruvian and Amazonian Indians and tribesman in Africa [2].

His observations found less than 1% of these people had decay in their permanent teeth. He found that freedom from caries always went hand in hand with freedom from chronic diseases like cancer and heart disease and infectious disease like tuberculosis, which at the time was a world-wide epidemic [2].

There are more current scientific studies that examine low caries rates and diet in populations that make for a stronger argument. Raner et al. found in a study that the Karen children and adults has a plaque physiology and microbiology predominating by low (levels) acidogenic anaerobes, which in addition to the low sucrose intake explains the low caries prevalence in this population [35].

Dental Caries and Systemic Disease

One of the etiological factors of dental caries is improper eating habits, which also influence the nutritional state of the organism [36] which can be seen in the relationship between the intensity of tooth decay and body weight disorders. Chiapowske et al. concluded that children with observed abnormal body weight status should be classified in the higher dental caries risk group [36].

Yao et al. found that the link between dental caries and obesity had been controversial and did a study. They concluded that obesity may have a significant effect on caries prevalence of primary school children in Wannan area, China. The importance of obesity should not only be emphasized with respect to general diseases, but also with regard to carious lesions [37].

Not every research group agrees with these findings. Panwar et al. found in a study that the children with normal BMI for age had more caries in their primary teeth as well as in their permanent teeth, than the overweight children [38].

Yang et al. stated that childhood obesity/underweight status and caries are both important public health problems. Their study of under-weight individuals found the most severe caries experience [39]. These differences of findings need an explanation by studying the components of the diet.

Some clarification to this discussion of weight and dental caries experience is found in another study. Costacurta et al. did a cross sectional study to evaluate the association between obesity and dental caries and to assess the impact of food intake, oral hygiene and lifestyle on the incidence of dental caries in obese pediatric patients, analyzed by Dual X-ray Absorptiometer (DXA). They found a direct association between dental caries and obesity evident from a correlation between prevalence of dental caries and FM%. They concluded that the intake of sugar-sweetened drinks, frequency of sugar intake limited to main meals, frequency of food intake between meals may be considered risk factors that are common to both dental caries and childhood obesity [40].

Not only is high sugar intake related to dental caries and systemic disease, but one of the means of delivering this high sugar intake is sugar sweetened beverages (SSB). SSB are the single largest source of added sugar and the top source of energy intake in the US diet. Vartanian et al. found associations between SSB consumption and increased energy intake and body weight, lower intake of calcium, and other nutrients, and increased risk of medical problems such as type 2 diabetes, hypocalcemia, dental caries, and elevated blood pressure [41].

Several reviews have presented evidence syntheses on associations between sugar sweetened beverages (SSB) consumption and metabolic syndrome/type 2 diabetes, weight, and cardiovascular disease [42].

The ingestion of SBB is important for everyone including infants. Hamel et al studied the intake of SSB during infancy and it was found to be related to obesity at 6 years of age [43].

SSB has been statistically significant increase risks of chronic kidney disease in patients consuming SSB, which may impact clinical management and primary prevention of CKD in high risk patients [44].

Reducing consumption of calories from added sugars is a recommendation of the 2010 Dietary Guidelines for Americans and an objective of Healthy People 2020. SSB are a major source of added sugars in diets of U.S. residents. Daily SSB consumption is associated with obesity and other chronic health conditions, including diabetes and cardiovascular disease. People who want to reduce added sugars in their diets can decrease their consumption of foods high in added sugars such as candy, certain dairy and grain desserts, sweetened cereals, regular soda, fruit drinks, sweetened tea and coffee drinks, and other SSBs [45].

A recently published meta-analysis of randomized clinical trials commissioned by the World Health Organization found that decreased intake of added sugars significantly reduced body weight. Another meta-analysis of eight prospective cohort studies found that one to two servings per day of SSB intake was associated with a 26% greater risk of developing type 2 diabetes compared with occasional intake. Two large randomized clinical trials with a high degree of compliance provided convincing data that reducing consumption of SSBs significantly decreases weight gain and adiposity in children and adolescents [46].

A New Vision

Dentists should promote better total health and that can begin with a healthy diet. Healthy diets could include: DASH; Dietary Approaches to Stop Hypertension, nutritionally sound diet endorsed by the Department of Health and Human Services and considered a top choice for preventing or controlling diabetes; TLC, Therapeutic Lifestyle Changes is a healthy choice; Mediterranean Diet showcases healthy foods like wholegrain pita and hummus, salads, fresh fruits and veggies, salmon and beneficial fats like olive oil, while these diets promote health with their ingredients, they also promote health by leaving out sugar, which promotes caries and systemic disease.

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