

SOME ADVANCES IN THE CONTROL OF TOOTH DECAY

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Among civilized peoples today decay of the teeth is one of the most prevalent of disease conditions, affecting 85-90 per cent of all such individuals. It is distinctly a disease of civilization as attested by the fact that primitive populations show an incidence as low as 3-10 per cent. Its progressive increase has paralleled that of the increased use of refined food, especially the carbohydrates. Despite the fact that reference to tooth decay has occurred among the writings of all people and in all times, some of the earliest scientific experiments and observations were made by Dr. W. D. Miller (1) about 1880. He isolated 22 bacterial forms from the mouth and decayed teeth and demonstrated that 16 had the ability to form acids when mixed with carbohydrates. He subjected extracted teeth to such mixtures and produced lesions comparable to those occurring in the mouth under natural conditions. The fundamental observations of Miller which related the oral acid forming bacteria and carbohydrate food material to tooth decay have never been successfully contradicted and are today a working basis for any method of control. After Miller's death (1907) little of real value was added to the knowledge of tooth decay until 1923. Starting then and working continuously for several years a group consisting of dentists, bacteriologists, nutritionists and physiological chemists began an intensive study of the saliva and blood of decay susceptible and decay resistant children, using orphanage populations. As a result they were unable to demonstrate any consistent significant group differences in the chemical nature of the blood or saliva (2, 3). However, in a bacteriologic survey (4, 5, 6, 7, 8) of decay free and decay susceptible individuals they found *L. acidophilus* consistently present in large numbers where tooth decay was active. This bacterium was absent, or only sporadically present in small numbers, where tooth decay was inactive. This relation has been substantiated by others (9, 10) and the relatively few contrary findings (11) are minimized by the fact that similar bacteriologic methods were not employed.

It has been adequately demonstrated that there is a direct relationship between the occurrence of *L. acidophilus* in the saliva and the activity of tooth decay, and that the quantitative estimation of salivary *L. acidophilus* is a relatively accurate index of the degree of such activity. That there are other acid forming bacteria involved is understood. The *L. acidophilus* count is used only as an index of the total acidogenic process.

There is definite evidence (12, 13, 14) of the effect of the ingestion of sugar on the activity of oral acidogens. Their activity and the resultant tooth decay are directly related to the amount of refined sugars in the diet of susceptible individuals. About 85 per cent of us are susceptible, about 5 per cent never have tooth decay, regardless of sugar intake, while about 10 per cent are so susceptible that refined starch continues to be a factor in their tooth decay when all refined sugars are withdrawn from the diet.

This is the now generally accepted status of the factors involved in tooth decay. The picture is incomplete, mostly in the area of true immunity which seems to have no relation to dietary factors. In these cases there is no acidogenic oral flora and attempts to grow *L. acidophilus* in either the saliva or the blood of such individuals have failed (15). There is some evidence (21) that this may be due to an ability to convert certain amino acids into ammonia nitrogen which acts as a deterrent to the growth of acid forming bacteria in the mouth.

Since 1939, the beneficial results of small amounts of fluorides naturally present in water supplies has been proved. Teeth of children which have developed

during the period of consumption of such water have shown a markedly lowered caries rate (16). Such teeth contain a greater amount of fluorides (17) and calcium salts are known to become less acid soluble through the addition of fluorine.

Within the past few years it has been reliably reported that the use of carcanimide (18) in dentifrices and mouth washes, synthetic vitamin K (19) in chewing gum, ammonia mouth washes, reported topical applications of sodium fluoride solutions on the cleaned surfaces of the *teeth of children* (24, 25, 27, 28) and the temporary elimination of refined carbohydrates from the diet (29) have each reduced the rate of tooth decay.

All these methods are based on possibilities of control which are compatible with what is now known about tooth decay, to wit, that it is initially a localized decalcification of hard tooth tissue by acid formed by oral bacteria acting on carbohydrate food material. These possibilities are:

1. Decreasing the intake of foods from which oral bacteria can form acids. This is the dietetic control and is being used for individual cases.

2. Direct inhibition of the growth of oral acid producing bacteria. This can be accomplished by the use of synthetic detergents (wetting agents), urea and ammonia.

3. Interference with the chain of reactions necessary to produce acids, such as occurs in the presence of synthetic vitamin K (quinone).

4. Reducing the solubility of the calcified tooth tissues in acids such as occurs in teeth developed on natural fluoride waters and such as may be the result of fluoride solutions topically applied to the enamel of children's teeth.

Of the above, the direct inhibition of bacterial growth and the interference with acid formation can be accomplished only for a very short time and to produce results they must be carried out immediately after any carbohydrate, especially refined sugar, has been eaten. Attempts to control tooth decay by such means are still very much in the experimental stage and more data will be necessary before their usefulness can be accurately evaluated.

Diet control will produce results and is being used rather widely. Its chief limitations are that it is an individual treatment and that patient cooperation is absolutely necessary. A period of six weeks divided into three two-week periods is used. The first period eliminates all free sugar and reduces other carbohydrates to 80-100 grams per day. If strictly followed it will reduce a high *L. acidophilus* count to zero in most cases. The second period introduces an increased amount of carbohydrate (not refined sugar) and the third period allows as much sugar or sugar sweetened food as desired at one meal per day. Salivary *L. acidophilus* counts at the end of each period show little or no increase, provided the prescribed diet has been followed. Following the dietary treatment, patients are checked at six-month intervals for two years. It is not unusual to find the *L. acidophilus* count still quite low at the end of this period. The length of the beneficial effect is proportional to the patient's ability to limit his sugar intake to reasonable amounts, following the restricted diet period.

Repeated topical applications of sodium fluoride solution to the cleaned surface of children's teeth is a practical procedure and will reduce the future occurrence of tooth decay by about one-third. This also has the limitation of being an individual method of treatment and is thus restricted in its application. It is practical and requires only that the patient report for treatment.

The fluorination of communal water supplies now deficient in natural fluorides (less than 1.0 P.P.M.) offers the best possibilities of wholesale reduction of tooth decay. In order to determine whether or not artificially fluorinated water can accomplish the same results as have been proven for naturally fluorinated waters, large scale controlled experiments are now under way (22, 23). The results will not be known for 8-10 years since they can only be judged on the basis of the decay which will occur in the teeth now being developed by children on such a water

supply. If successful, this will offer a public health measure of tooth decay control which can be applied to all children raised on communal water supplies. This would reach about two-thirds of our child population. If it is as effective as natural fluorides it will effect a reduction of tooth decay in children to about one-half of its present rate.

In summary, we are now in possession of considerable information, the application of which could markedly reduce tooth decay if it could be easily and generally employed. There is no proof that tooth decay is related to dietary deficiencies but there is a great deal of proof that it is related to the excessive consumption of refined carbohydrates, especially sugar.

Sugar rationing and threats of sugar shortages are amusing. From the standpoint of tooth decay the complete elimination of all refined sugar from the diet would be a godsend to the present generation of children. Neither would it do harm to the waistline and few remaining teeth of their elders who still persist in the erroneous belief that candy is essential to child development and happiness.

While the proper use of fluorides will reduce tooth decay their role is palliative. Specifically fluorine acts to slow down the destructive effect of localized acid production. This acid would never have been generated in the absence of acid forming oral bacteria nourished by refined carbohydrates from food.

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