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DENTAL CARIES

Mechanism and Present Control Technics
as Evaluated at the University of
Michigan Workshop

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PROPHYLAXIS, TOOTHBRUSHING, AND HOME CARE OF THE MOUTH AS CARIES CONTROL MEASURES

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It is generally accepted that dental caries begins on exposed surfaces of the teeth, and that bacteria which accumulate there are involved in the process. Most authorities agree that the carious process is initiated by acid action, although proteolysis has been suggested. In either event, the process may be diagrammed as follows:

- (a) Microorganisms + suitable media → harmful products.
- (b) Harmful products + susceptible surface → dental caries.

A myriad of other factors, such as rate of acid production, the solubility of enamel, buffering capacity of saliva, must be considered, of course, but it is obvious that the presence of bacteria and suitable media for these bacteria are necessary for the formation of dental caries. Our experience and study have convinced us that the initial step in the carious process is a decalcification of enamel by acid produced by acidogenic bacteria degrading freely fermentable carbohydrate, but a debate of this question is beyond the scope of this paper.

It is also generally accepted that since the carious lesion begins in a relatively small circumscribed area bacteria must be localized, probably by a bacterial plaque, and held in close contact with enamel before the lesion called dental caries is produced. It is natural, therefore, that removal of these bacterial plaques, as well as mechanical removal of the bacterial media, be con-

sidered a method of caries control. The well-known slogan, "A clean tooth does not decay," was coined apparently by Dr. J. Leon Williams years ago,² but the idea was stated in other ways as early as 1530.³

In 1934 a debate was held before the greater New York meeting on the subject "Resolved: That a clean tooth does not decay, and that mouth cleanliness affords the best-known protection against dental caries."⁴ Six well-known dentists took part in this debate, but no conclusions were reached; an editorial in the issue of *Dental Cosmos* containing these papers stated that "... we are of the opinion that both sides won this case."⁵

We are convinced that this slogan, "A clean tooth does not decay," is completely correct, if one defines a clean tooth as one which at all times is free of harmful microorganisms and/or free of media for the organisms to utilize. The question to be discussed, as far as I am concerned, is "Can a tooth be kept 'clean' enough, by mechanical means, to prevent or to reduce the incidence of dental caries?"

Although this is an obvious and practical question, few truly scientific studies of this problem have been made. Practically everyone writing on caries control has mentioned the importance of maintaining oral hygiene in inhibiting dental caries, but has given no definite evidence to support the statement. Incidentally, every clinician knows that filthy teeth are not always decayed and that apparently "clean" teeth are often carious. In fact, bacterial plaques, capable of producing an alkaline reaction, may actually protect against dental caries.

Fosdick⁶ reported one study on the effect of toothbrushing by twenty caries-active patients immediately after eating. These patients used an antiseptic rinse, antiseptic paraffin, and a toothbrush with a dentifrice. The conclusions were that there was an appreciable decrease in susceptibility of every patient in the test. Doubtless, the reduction in caries activity noted in this experiment was due to mechanical cleansing in part, but the use of medicaments in the experiment makes it difficult to evaluate the efficiency of the cleansing action alone.

Fosdick⁷ also reported that he now has approximately 1,000 people brushing their teeth immediately after each ingestion of food. He should have concrete data on this question in another year or so.

In two independent hamster studies, brushed control animals were compared with unbrushed control animals, and in both studies the brushed hamsters showed less dental caries than the unbrushed animals by 20 per cent or more. The two experiments were carried out by Zander⁷ and Lazansky.⁷ Both reports are definitely preliminary in nature, and this reference may be premature, but these studies do represent an attempt to establish the value of toothbrushing in caries control, and the evidence to date seems promising. Apparently final scientific evidence on the actual value of mechanical cleansing in dental caries control is lacking, but because of the obvious possibilities involved, must be considered. Mechanical cleansing of the teeth may be classified into five methods:

- A. Prophylaxis by dentist or hygienist
- B. Brushing by patient

- C. Mouth rinsing
- D. Use of dental floss or toothpicks and various gadgets designed to clean interproximal surfaces
- E. Incorporation of detergent foods in the diet

A. Prophylaxis:

Routine scaling and polishing of the teeth by dentists or hygienists at intervals of from three to six months are of positive value in prevention and control of periodontal diseases, but probably have limited value in the prevention of dental caries. Hine and Bibby,⁸ in studying the constancy of the oral flora a few years ago, collected bacteria from the distal surface of a lower second molar and a caries-free occlusal fissure sixteen times in eighteen days. Each day a scaler was used, and each time an ample supply of bacteria was found. In another study, we collected material from ten adults every two weeks for twelve weeks. Using the same scaler each time and definite finger rests, attempts were made to collect bacterial plaques from the same areas each time. In every instance it was very easy to obtain bacterial accumulations for study. Obviously, if plaques re-form so rapidly, then removal every three to six months has questionable value. Probably of more importance than mechanical cleansing of the teeth in a prophylaxis is the careful polishing of roughened tooth surfaces and the correction of poor restorations already present. This may conceivably reduce the liability of retention of food particles and bacterial plaques and thus reduce dental caries. No accurate estimate of the efficiency of oral prophylaxis in caries control is available, however.

B. Toothbrushing:

If toothbrushing is to be effective, the following requirements must be fulfilled:

1. The toothbrush must remove the food debris immediately after eating. Stephan⁹ and Fosdick¹⁰ have independently demonstrated that acid production occurs almost immediately after food has reached the bacterial plaque. So toothbrushing must be done immediately after eating to be very effective. As Knutson¹¹ pointed out, such a procedure will probably never receive the sanction of authorities on etiquette.

2. Toothbrushing, to be effective, must be done thoroughly. Casual brushing of exposed surfaces of enamel, already cleansed by excursion of food, will not prevent or reduce interproximal or pit and fissure caries. Gottlieb² mentioned that the Charters' method of toothbrushing is the correct one to use "from the caries viewpoint" but it is admittedly a time-consuming, tedious task to brush all surfaces of all teeth.

A study made by Robinson¹³ suggests that the average young adult spends about sixty-seven seconds in brushing his teeth. Certainly this is not enough time to allow thorough cleansing of each interproximal surface. Incidentally, Robinson found that the left side of the mouth received an average of three more strokes than the right. Inasmuch as the bilaterality of caries is well estab-

lished (Scott¹⁴), it would appear that the toothbrush has not played a prominent role in caries control, or at least that the extra strokes on the left are of no value.

Several studies have demonstrated that toothbrushing can reduce the number of bacteria in the oral cavity, but no comments were made regarding the effect of this reduction on dental caries.

Kligler,¹⁵ after his experiments on three patients showed sharp reductions in numbers of bacteria after toothbrushing and mouth rinsing, concluded: "The results indicate, in accordance with prevailing opinion in regard to oral hygiene, that washing teeth before retiring is very desirable, and that rinsing the teeth after each meal is just as expedient a habit to cultivate as washing the hands before a meal." He made no attempt to determine the effect on dental caries of reducing the number of oral bacteria.

Crowley and Rickert¹⁶ developed an interesting method of determining the numbers of bacteria that can be removed from the oral cavity. Their findings, based on application of their method, were that three hours after brushing (twenty-four counts made on four subjects) there was an average decrease on numbers of bacteria of 12 per cent. In a fifth subject (three counts made) there was an increase of 27 per cent in numbers of bacteria removed three hours after the original brushing. Six hours after brushing (twenty-four counts made on four subjects) there was an average decrease of 4 per cent from the number removed at the initial brushing. In the fifth case, there was an increase of 21 per cent above the number removed at the first brushing.

Florestano, Elliott, and Faber²¹ made several studies to test the effectiveness of different materials in removing microorganisms from the oral cavity. They found that brushing the teeth with water using Charters' vibratory technique for two minutes, reduced the culturable bacteria that could be collected by 46.7 per cent. Two hours later, however, the count had risen 268.5 per cent.

The experiments mentioned and others indicate that even after thorough brushing of teeth there are still uncounted millions of bacteria remaining in the oral cavity and that more will appear. Therefore, we must conclude that toothbrushing, mouth rinsing, detergent foods, and other mechanical cleansing agents are only partially successful in removing oral bacteria, and hence, at best could do no more than reduce dental caries.

Another possible benefit from brushing the teeth may be that it will make them smoother and prevent the collection of food debris and bacterial plaques. There is no doubt that the toothbrush with a suitable polishing agent in a dentifrice will polish enamel. Theoretically this should reduce dental caries by reducing food retention and perhaps plaque formation. Certainly polishing teeth is esthetically valuable; it increases the brilliance of one's smile. However, even highly polished enamel is still microscopically very uneven, affording excellent areas for bacteria to lodge.

Statistics show that during the past generation there has been an increase in dental caries *and* in the sale of toothbrushes. One must conclude that toothbrushing as commonly practiced is not a good caries control procedure.

C. Mouth Rinse:

Value of a nonmedicated mouth rinse as a mechanical cleansing agent, particularly following toothbrushing, has been mentioned by several writers. Fosdick⁶ has suggested it as a simple and fairly unobjectionable method of cleansing the mouth immediately after eating. Theoretically, this should be helpful; actually, no accurate scientific data are available regarding its value.

D. Use of Dental Floss, Toothpicks and Various Gadgets Designed to Clean Interproximal Surfaces:

The same statement can be made for the use of toothpicks, dental tape or floss, and gadgets for interproximal polishing of teeth. They should be of value in isolated instances, where food impaction occurs, but no reports of well-controlled studies are available, so far as I know, which would prove that the incidence of caries was reduced by their use.

E. Detergent Food as Cleansing Agents:

Crowley and Rickert found that after eating there was a reduction of as much as 78 per cent in the numbers of bacteria that could be removed. This finding was also made by Kligler,¹⁵ Wallace,¹⁷ and Knighton,¹⁸ and suggests that mastication of food is the best way to reduce the bacterial count of the oral cavity. In fact, Volker¹⁹ has recently stated that eating of fibrous foods after meals is to be recommended as a method of caries control. Howitt, Fleming, and Simonton,²⁰ however, fed an inmate of San Quentin Prison several diets, "sticky," detergent, and liquid (by tube), and concluded that artificial cleansing with a toothbrush is many times more effective in reducing the absolute numbers of mouth organisms than the supposed cleansing accomplished by a diet containing detergent foods. However, the fact that areas of teeth exposed to food excursion are so-called areas of immunity, suggests that mechanical cleansing by detergent foods has some value in caries control.

In discussing mechanical cleansing of the teeth, one should consider possible harmful effects that might result. The following should be mentioned:

1. Removal of enamel cuticle undoubtedly results from rigorous cleansing of teeth. No one has proved this to be harmful, however.

2. Abrasion of enamel can occur. However, tests by many, including myself, indicate that while the common dentifrices can wear away cementum and dentin, they are not abrasive enough to affect enamel seriously. The actual amount of enamel lost by toothbrushing is probably not an important factor in dental caries.

3. Mechanical cleansing of the mouth carelessly done may result in gingival recession, exposing cementum which is probably more susceptible to attack by dental caries than enamel (as noted in "senile caries").

4. Will polishing enamel remove or weaken the effects of a fluoride applied topically? If dentists are to continue to recommend topical applications of fluoride solutions, it is necessary to know if mechanical cleansing of the teeth can interfere with its action by removing or altering the surface of enamel. This

seems an important question and although it is presumed that topically applied fluoride reacts with the enamel to produce a more insoluble chemical compound, no definite research data have ever been published to show the actual depth to which fluoride penetrates, and reacts with, the enamel. It is important that the fluorapatite formed in this reaction should be of sufficient depth or hardness to prevent complete removal by prophylaxis or continuous use of a highly abrasive dentifrice.

A study by Phillips⁷ of the effect of fluorides upon the hardness of enamel may be summarized as follows: Perfectly flat, highly polished enamel surfaces were prepared on twelve sound molar teeth. Original hardness measurements were then made by means of the Tukon hardness tester, and these teeth immersed in 1:500 tin and sodium fluoride solutions. Following a five-minute immersion period, hardness readings were again made. The percentage increase in hardness of the enamel was 9.9 per cent with tin fluoride and 7.5 per cent with sodium fluoride. The teeth were then brushed for one minute with a slurry of medium grit laboratory pumice by means of a motor-driven Crescent brush. Following the pumice brushing, hardness indentations were again made. There is no particular hardness change noted in the enamel surface following this severe brushing treatment. For example, the enamel gained 9.9 per cent in hardness when immersed in tin fluoride and still showed a gain of 8.5 per cent after the pumice brushing. For sodium fluoride the gain was still 7.1 per cent after brushing. (These figures represent an average of at least five readings in each of six individual teeth.)

A further check on the protective action of the fluorides is to observe the subsequent effect of organic acids on the hardness. Therefore, these same teeth which had been treated with sodium fluoride and then brushed with pumice were immersed for five minutes in acetic acid (pH₄), after which hardness measurements were taken. The final hardness was 3.7 per cent higher than before the use of the fluoride solution; the acid naturally had reduced the hardness somewhat. However, teeth untreated with fluoride and immersed for five minutes in acetic acid showed an actual hardness loss of 6.2 per cent. This experiment indicates the surface was still protected even after one minute of pumice brushing. Contact of tooth surface with 1:500 tin fluoride for twenty-five minutes formed a layer of enamel hard enough or deep enough to remain even after four minutes of brushing with pumice. Further tests are being made on this subject.

It is probably true that rigorous polishing of teeth mechanically will not materially reduce the effectiveness of topical applications of fluoride solutions.

SUMMARY

There is considerable evidence in the literature that mechanical cleansing of teeth will reduce the numbers of bacteria in the mouth and on the teeth. Certainly frequent mechanical cleansing will also reduce the volume of media for microorganisms to utilize. It is probable, therefore, that the cleaner the teeth the less likely they are to decay.

However, it is apparent that the numbers of oral bacteria quickly return to a high level soon after mechanical cleansing, and that it is not possible to remove all oral bacteria by mechanical procedures alone. This coupled with the facts that the cleansing must be done thoroughly and immediately after eating if it is to be effective, makes mechanical cleansing of teeth of limited value in dental caries control. More carefully controlled clinical research must be done to determine the effectiveness of mechanical cleansing.

CONCLUSIONS

1. Widespread mechanical cleansing of the teeth with detergent foods, a toothbrush, a nonmedicated mouth rinse, can be recommended because of its esthetic value, beneficial effects on gingival tissues, and possible interference with dental caries. Routine mechanical cleansing of teeth is apparently not harmful.

2. Because there is no known way of removing mechanically all bacteria and food debris from the teeth for any length of time, mechanical cleansing of the teeth alone cannot be expected to prevent caries.

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DISCUSSION

DR. DONALD A. WALLACE.—I should like to comment on one feature of this paper, the studies on removal of bacteria and other materials from the mouth. The phrase used early in Dr. Hine's paper was "the number of bacteria in the oral cavity."^{*} The number that can be rinsed out or removed mechanically is sometimes taken as a measure of the number in the oral cavity. Actually, as Dr. Hine made clear later in his paper, we don't know how many bacteria there are in the oral cavity. It is impossible to count all of them, or even to remove all of them. When an author refers to the number of the bacteria in the oral cavity, he very generally means the number he was able to remove by some arbitrary procedure.

^{*}In the final paper, Dr. Hine corrected this phrase to conform to Dr. Wallace's suggestion.—Ed.

DR. HINE.—Actually nobody knows how many bacteria there are in the mouth, and I know of no way to find out. We can't kill all of them, and we must admit that there are always innumerable bacteria left in spite of any technic for mechanical cleansing we can use.

DR. BASIL G. BIBBY.—I am a little cynical on this tooth cleaning business. I wonder whether the problem isn't that when we clean our teeth we never get our cleaning mechanisms—be they patient-applied or dentist-applied—into the areas where caries really originates. Until we can demonstrate that we can actually influence the plaque or the tooth surface accumulations through the depths of the fissures or interproximal spaces, I don't think the problem has too much bearing on what we are trying to answer.

I might mention two studies which cast a little light on the problem. One was by Garvin in Winnipeg, who had a fairly good group of patients in his private practice to whom he gave regular prophylaxis. He showed improved carious condition in those patients. The other was the study by Hyde, carried out in Boston on the inductees in the First Service Command in which he correlated the number of times the patient cleaned his teeth with the amount of dental caries, and got a very nice correlation. Those who cleaned their teeth once a day had less caries than those who cleaned them twice a day, and so on out, with seven neurotic people who were cleaning their teeth five times a day. The correlation was a beautiful straight line correlation: the more tooth cleaning, the more dental caries. However, we have to distinguish between cause and effect; we have to bear in mind that the patients who clean their teeth most may be cleaning them most because they are worried about their teeth, maybe because they have dental caries.

DR. HINE.—I believe that Dr. Bibby agrees that we have no scientific evidence that is adequate to prove that toothbrushing is a good method of caries control. Certainly the report by Gavin (*J. A. D. A.* 20: 27, 1933) should be mentioned, but he points out that a prophylaxis given periodically has not been proved a good method to control caries.

Until someone can prove that it is in the least degree harmful, I shall continue to recommend that patients continue to brush their teeth vigorously.

DR. JACK M. EARLE.—I believe Dr. Hine mentioned tin and sodium fluoride solutions. Would he tell us what concentration solution he used there?

DR. HINE.—One to 500 solution of tin fluoride and 1:500 solution sodium fluoride were used.

DR. F. D. OSTRANDER.—Was there any special reason why you used tin fluoride?

DR. HINE.—In the studies that were made at Indiana and other places tin fluoride was found to be more effective than sodium fluoride.

DR. PHILIP E. BLACKERBY.—Will Dr. Fosdick or Dr. Stephan express their views regarding the possible effects on caries incidence from the use of mechanical agents, brushing, or irrigation immediately after the ingestion of food?

DR. STEPHAN.—Well, if one could clean the teeth immediately after eating, it would be best. Of course, it takes a considerable length of time to eat in the first place, so that it is hard to see how one could keep them clean as he goes along eating a meal, but if one could do it, I think, as Dr. Hine suggested, the chances are that it would only be partially effective in cleaning the different surfaces of the teeth. As to whether that would really produce the equivalent partial reduction of caries, I don't think we have any evidence at the present time. Certainly since the areas that can be cleaned by our regular prophylactic methods are not the areas susceptible to caries, as Dr. Bibby pointed out. I would certainly reserve judgment until it was actually shown with acceptable scientific data that such was the case. So, it seems to me that the burden of the proof would be on anybody who wanted to establish that immediate cleaning was effective. It may be so, but it doesn't seem a practical method so far as I can see.

DR. EASLICK.—I think perhaps Dr. Blackerby had in mind whether it would remove enough of the sugar solution perhaps to prevent caries.

DR. BLACKERBY.—Well, perhaps if we should decide that we are going to continue, as Dr. Hines suggests, to recommend that patients brush their teeth, then is there an optimum time during the day which that should be done? Are we justified in prescribing that the patients use the toothbrush, if they are going to use it, immediately after the meal, or whenever possible, or is any time of the day effective?

DR. STEPHAN.—I assume that neither is effective.

DR. FOSDICK.—I can say that I don't know. However, I would say also, from a theoretical point of view, toothbrushing should be done immediately after eating for it to do any good. Now, of course, we don't know how much good brushing the teeth will do, or how clean it will make a tooth. For instance, back about 1938 one of our students had a problem of finding out how much cleansing brushing the teeth will do. The method of procedure was to brush one tooth for one full minute and then extract the tooth and stain it to see how much "dirt" remained on it. We couldn't actually determine this, but on the mass basis the maximum removed by brushing was 27 per cent. Now, there is some evidence, I believe, to indicate that flushing the mouth out with plain water may be beneficial. It is not good evidence, but combined with the theoretical evidence it is worth while. It may not clean the teeth, but it certainly could dilute various things that would make it effective.

DR. HINE.—I doubt if we can expect patients to brush their teeth adequately enough for brushing to be a method of caries control. If a person takes a bite of candy the figures, that were shown yesterday and previously, indicate that there is an appreciable amount of acid produced within a very few minutes. Assuming for a moment that it would be possible to cleanse every interproximal surface completely, it would have to be done so quickly that it is not practical. For instance, the average meal takes longer than ten minutes to eat, and if a person takes a bite of fermentable carbohydrate, the reaction starts on the enamel before the patient finishes the last cup of coffee. I believe we must admit it is not a practical method of preventing dental caries. I do believe, however, that if patients brush their teeth after every meal, they will remove considerable debris that might, from a quantitative point of view, allow decalcification to continue longer; a mass of food might allow acid to continue to form for several hours. In a patient who is not particularly susceptible to dental caries, with only a few acidogenic organisms, it may be that it would take several hours for the acid to be produced in quantities sufficient to allow a mass decalcification of tooth structure and cause caries. So, at the present time the only statement that we can make is that theoretically it sounds plausible to remove the media from bacteria and as many of the bacteria as possible from tooth surfaces. We should do this as soon as feasible, and hope that a reduction of dental caries will result.

DR. BLACKERBY.—What is the optimum time for brushing the teeth?

DR. HINE.—I think the toothbrushing can well be done at least before retiring and upon rising. For certain patients that need it, it should be done after meals.

DR. R. W. BUNTING.—I have been very much interested in this discussion, but there are one or two basic facts that I think should not be overlooked. We have been disappointed in the fact that we couldn't control dental caries with the toothbrush, but I think that most of us will admit that we know of many very dirty mouths that have no caries, and of many apparently clean mouths that do have caries in abundance. When caries occurs in the dirty mouth isn't it more likely to be rampant, widespread, and involve more areas of the teeth, while in the clean mouth it is more discrete, and much less extensive? So can we not say that although cleanliness of the mouth in general does not determine whether or not caries shall occur, it does influence the degree of caries activity? Now, one point that has not been raised is significant in my opinion. There is one type of caries that is positively amenable to cleansing with a toothbrush, and that is the typical cervical caries which can be stopped by proper toothbrushing. It is the only kind of caries that can be thus controlled, in my opinion.

DR. HINE.—Dr. Bunting's points are good. It has been suggested that perhaps we are not wise in considering dental caries as always the same process, but should begin to evaluate it more critically. We all have noted that certain mouths are attacked by interproximal caries, other patients have gingival caries as the prominent type, and of course many patients have both types. It is perhaps not quite scientific to group all of these different types of dental caries under the same general heading as though they were identical. I believe that we can agree very definitely with Dr. Bunting that gingival caries appears in mouths where there is a great collection of debris around the mouth; whether that can be controlled by careful brushing or not has not yet been scientifically approved. Dr. Bunting states that it is his opinion—and I imagine that it is the opinion of most of the clinicians in the room—that brushing the teeth in a certain way a certain number of minutes for a certain time reduces certain types of caries a certain amount. At present we don't have the facts, as far as I know, with which to give specific facts regarding caries reduction by the use of a toothbrush.

DR. BENJAMIN M. MEDOF.—The doctor spoke in the brushing of the teeth about the possibility of injuring the delicate Nasmyth's membrane. Now, how long after the tooth eruption does the membrane stay on the tooth, and if it does stay on the tooth, does it probably have any effect on the control of caries?

DR. HINE.—I would just as soon pass that question on to an histologist. Apparently it can be worn away rather easily, and probably is not a factor in caries whether present or not. It is probably gone from most of the areas of the mouth that can be brushed. Actually, we have no facts with which to answer your question.

DR. SAMUEL W. CHASE.—I think Dr. Hine answered his question on the enamel cuticle very nicely. It is a transitory thing, and doesn't have much to do with a tooth that had been erupted for any time.

DR. THOMAS J. HILL.—I should like to support Dr. Hine's contention that we should go on advocating the brushing of teeth, and I should like to refer to the old experiment which was conducted in Cleveland at the Marion School where they took a couple of different classes back in '12 or '14 and in a class, or one group of children in this school, had tooth-brushing drills every day over a fairly long period of time. Some fifteen or twenty years later Dr. Harry Wilson went out and collected all of these former students that he could to see whether there had been any evidence that value had been received from the brushing of the teeth. They found that during this fifteen or twenty years the incidence of caries in these two groups of people had been identical, but there was one outstanding difference, and that was that the children who were in the class that had been taught to brush their teeth had very much better teeth because they had become mouth conscious and had had fillings and various other dental work done, so that their teeth were in far better condition. So, I think that there is perhaps a psychological aspect to this also. Brushing of the teeth should be advocated.

Dr. Hine has told us that there are many very dirty mouths that do not have significant dental caries. I think it has been pretty well established that the difference in the plaques that occur in those mouths is that those plaques are primarily proteolytic organisms rather than aciduric organisms. Advocates of the Gottlieb theory should explain why this increased number of proteolytic bacteria in these plaques decreases the incidence of caries rather than increases them.

DR. HARRY STRUSSER.—Has the effectiveness of hand polishing with the portepolisher been compared to the rubber cup in mechanical cleansing?

DR. HINE.—We have no good evidence that proves that the hand-polished tooth is less susceptible to caries than the one that is polished in the routine way. One can admit immediately that a tooth hand-polished by an expert will be smoother and cleaner than one polished in a superficial manner by a rubber cup. Therefore, from a theoretical point of view, the hand-polished tooth should be less likely to decay. I hope that the time will come when some

good clinician will be able to remove the word "theoretic" from my statement. We don't know whether the hand polishing can be done often enough and thoroughly enough to be effective. We can only state that we will admit it will be smoother and cleaner for a short time at least, and have to let it go there.

DR. JOHN W. KNUTSON.—I would like to have Dr. Hine elaborate on the last conclusion, considering time spent in hand polishing and mechanical polishing. Are they the same, or as I would expect, is perhaps five or ten minutes spent in mechanical polishing and perhaps a half hour in hand polishing?

DR. HINE.—My comments were directed toward hand polishing a tooth by a dentist using a porte-polisher very carefully and very tediously, polishing every surface of the teeth, including areas where a revolving brush or revolving cup could not reach. As far as the patient brushing teeth, how long does it take a patient to brush his teeth in order to clean them adequately? In some mouths it can be done in perhaps ninety seconds, in other mouths, where there is a malocclusion, pathologic pockets, we want the patient to spend from three to five minutes brushing the teeth. I know of a few very fastidious patients who spend ten minutes in the morning and ten minutes at night brushing their teeth. It is all a matter of degree, because even after ten minutes of careful brushing, there will be certain areas of the mouth that will still not be thoroughly cleansed. From a practical point of view everyone in this room probably should spend from two to four minutes and then he can say, "Well, I have done about as well as could be expected." Does that answer your question satisfactorily?

DR. KNUTSON.—Not quite. I was referring to the polishing by the dentist, or the dental hygienist in the office. I understood your statement to say that the hand polishing, porte polishing, was much more effective than the mechanical polishing by a rubber cup. Now in your conclusion did you take into account the difference in the time involved?

DR. HINE.—No, sir. I think that the hand polishing will be accepted by most as being the most effective for interproximal areas and root surfaces, particularly in pockets. I believe at the same time that the average clinician will not feel justified in spending the time involved to do that. Assuming the rubber cup would be, shall we say, 75 per cent effective, the other 25 per cent would take an extra twenty or thirty minutes with hand polishing.

DR. BIBBY.—One point might be added; Dr. Brudevold has been exposing a standard window on a tooth surface and then submerging the tooth in acid, analyzing the tooth from the amount of tooth substances lost. Taking this in successive immersions in acid he finds that in the first exposure to acid the solubility is considerably less than in all subsequent exposures to acid. If, however, he does clean the tooth surface with an ordinary prophylactic procedure, using a brush and pumice, then his initial exposure to acid has the same solubility as in the deeper surfaces of the enamel, suggesting that by that procedure of polishing one can remove what seems to be an external and very thin layer of added resistance to acid on the outside of the tooth.

DR. ROBINSON.—Do you infer by that, that some enamel is removed or does polishing remove some sort of a cuticular structure?

DR. BIBBY.—I don't know. I have a suspicion we should regard the change from the enamel plaque into an inorganic enamel not as a sharp boundary, but as a transition in which one finds progressive amounts of inorganic material by proceeding toward the enamel; it takes a harder cleaning to get this outside surface off. So, I assume it is something at least partly calcified. It is, however, a very thin layer. Getting back to Dr. Hine's experiments with fluoride, we find that the first immersion in acid apparently erases the fluoride effect, which is a little different result from what he obtained.

DR. ALLEN O. GRUEBBEL.—I should like to ask Dr. Bibby a question based on what he just said. Might a thorough cleansing of the tooth therefore encourage a carious lesion?

DR. BIBBY.—I have no personal knowledge of that, but there are two reports in the literature of people who went through life caries-immune to the age of forty or so, went to their dentist, got a real polish, and from then on were highly caries susceptible.

DR. EASLICK.—If you people will please come to order, I can promise you a treat in the last speaker of the symposium this morning.

The next speaker, I suspect, will discuss both the caries process and some of the controls on which he has been pursuing research. It was rather interesting in last night's newspaper to note that the thing that was most intriguing about this conference was the fact that the dentists were going to discuss chewing gum and vitamin K. At least, that was the publicity in the Ann Arbor Daily News. Having heard the next speaker quite recently at Northwestern University where he presented this subject of dental caries most lucidly, I can promise you a very informative forty-five minutes. Dr. Fosdick is professor of chemistry at the School of Dentistry at Northwestern University, and he has been assigned the subject by the committee "The Degradation of Sugars in the Mouth and the Use of Chewing Gum and Vitamin K in the Control of Dental Caries." It is certainly a pleasure, Dr. Fosdick, to have you repay my visit to Northwestern.

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