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EFFECT OF TOPICALLY APPLIED AGENTS ON ENAMEL

I. Methods for experiments *in vitro*[1]

by

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Several experiments *in vitro* have been made to evaluate the caries inhibiting action of various chemical compounds dissolved in water and topically applied on dental enamel. As a rule these methods are based on the assumption that demineralization represents one of the main features in dental caries and that, consequently, the caries resistance ought to be increased by the establishment of a higher acid resistance of the enamel surface. In some cases the results of the chemical tests are in agreement with results obtained clinically. In other cases, however, the clinical findings contradict the test-tube results.

Sodium fluoride in unbuffered solutions is reported to increase the acid resistance of enamel (*Volker,* 1939, *Buonocore* and *Bibby,* 1945, *Muhler, Boyd* and *van Huysen,* 1950, and *Ericsson,* 1950). Topical application of neutral sodium fluoride solutions reduces the caries incidence (*Bibby,* 1944, *Knutson* and *Armstrong,* 1946).

Experiments *in vitro* have shown that acidulated sodium fluoride solutions increase the acid resistance of dental enamel more than do neutral solutions (*Bibby,* 1947, *Phillips* and *Muhler,* 1947, and *Lazansky,* 1947). Applied topically *in vivo,* however, acid sodium fluoride solutions were not found to have any caries inhibiting effect (*Rickles* and *Becks,* 1951). Similar negative findings were reported from clinical experiments with acid potassium fluoride (*Stones, Lawton, Bransby* and *Hartley,* 1949). Acidulated sodium fluoride solutions used in mouth washes seem

[1] This is the first publication of a series which will appear in this journal. It was received by the editor on August 6, 1956.

to be caries activating (*Lazansky*, 1947, *Bibby*, 1948, *Roberts*, *Bibby* and *Wellock*, 1948).

According to chemical tests stannous fluoride increases the acid resistance of enamel (*Muhler* and *van Huysen*, 1947, *Muhler*, *Boyd* and *van Huysen*, 1950, *Ericsson*, 1950), and applied topically it has resulted in caries reduction (*Howell, Gish, Smiley* and *Muhler*, 1955). In contrast to stannous fluoride, lead fluoride has given questionable clinical results (*Bibby, de Roche* and *Wilkins*, 1947, *Galagan* and *Knutson*, 1947, *Klinkenberg* and *Bibby*, 1950), in spite of chemical tests showing it to increase the acid resistance of enamel (*Buonocore* and *Bibby*, 1945, *Muhler, Boyd* and *van Huysen*, 1950, and *Ericsson*, 1950).

According to *Lazansky* (1947) and *Manly & Bibby* (1949), indium nitrate solutions seem to give highly acid resistant enamel surfaces. However, the brushing of hamsters' teeth with indium nitrate solutions resulted in increased caries activity (*Lazansky*, 1947).

The findings mentioned above indicate that obviously it is impossible to predict the caries inhibiting effect of a compound which, according to chemical tests, decreases the solubility of enamel *in vitro*. Hence it seems valuable to investigate the relation between acid resistance and caries resistance by means of other methods. Some experiments dealing with the problem discussed above are reported in this paper.

I

INTRODUCTORY EXPERIMENTS

MATERIAL AND METHOD

For the experiments were used newly erupted premolars which had been extracted in the routine of orthodontic treatment of children, 11 to 14 years of age. On the buccal surfaces of the teeth, areas which macroscopically appeared normal and intact were isolated by means of blue inlay wax and the area divided into two halves by a longitudinal sulcus filled with the same wax (Fig. 1). The rest of the tooth was covered with Tenax wax. Aqueous solutions of various chemical compounds were applied on one half of each experimental area. Each agent was allowed to act for 10 to 25 minutes. For the purpose of control, the other

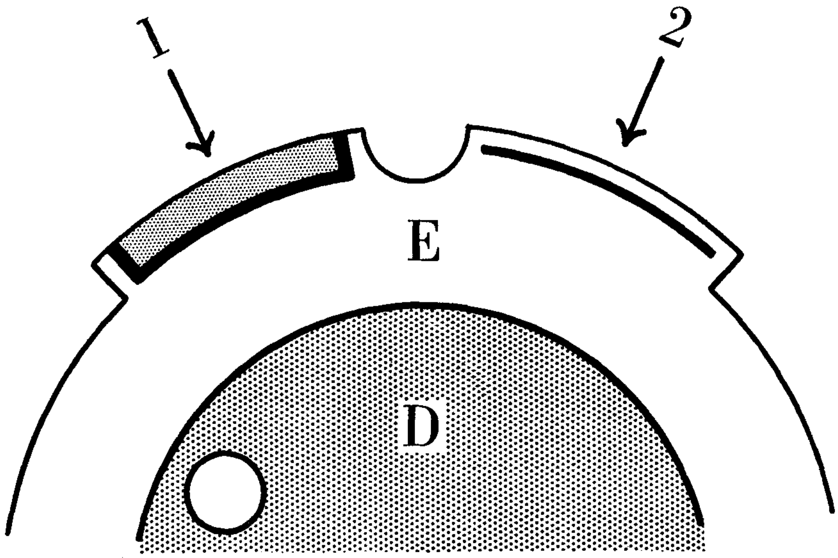


Fig. 1. Schematic drawing of ground section, perpendicular to the longitudinal axis of the tooth. Imbibition in distilled water, polarized light. D = dentin, E = enamel. Longitudinally running sulcus divides experimental area of the enamel into untreated part (1) and treated part (2). The former is marked by a drilled hole in the corresponding dentin area. Experimental area is laterally marked by a flat step in the enamel on both sides.
In this specimen the untreated half shows a broad outer spot without cavity, while the treated half shows an initial inner spot. ("Marked difference").

half of the experimental area was kept moist with distilled water during the same period. Excess of the applied solution was then sucked up with filter paper. Over the entire experimental area tubes were mounted, according to the method described by *Hals, Mörch* and *Sand* (1955). The tubes were filled with lactate buffer solutions of constant ionic strength, but with varying hydrogen ion concentration. The time of exposure to the buffers was adjusted to their pH. After termination of the experiment, ground sections were prepared for examination in a polarizing microscope.[1]

The acid resistance of the treated areas was evaluated by registering the appearance of outer and inner spots as described by *Hals, Mörch* and *Sand* (1955):

[1] For better contrast between the enamel surface and the background the analyzer was in some cases turned 5—10° backwards from crossed position in relation to the polarizer.

"On examination in polarized light with imbibition in distilled water two main types of defects were observed which could be characterized as inner spots and outer spots (see Fig. 2). Both principal types could be further subdivided. The outer spots manifested themselves macroscopically as dull whitish areas, with or without a loss of substance. On the microscopic examination an outer spot without loss of substance showed positive birefringence in the external zone of the enamel, separated by a narrow isotropic zone from the intact negative double-refractive enamel lying deeper. With short exposure to the lactate buffers the alteration of the enamel in some cases was only a narrow isotropic zone in the surface layer of the enamel. In the case of an outer spot with loss of substance it was limited by a narrow positive double-refractive zone with an isotropic border zone. The inner spots manifested themselves macroscopically as slightly opaque spots with a shiny, apparently intact surface. On microscopic examination of inner spots the enamel showed a surface layer of varying width where the negative birefringence was retained. Inside this layer the real defect was found which in its characteristic form consisted of a positive central area with isotropic border zones".

In the same article is mentioned that sometimes inner and outer spots appeared simultaneously. This complicated type of defect was seen more often in the present experiments, especially in those carried out with a modified method (see Chapter II). A schematic drawing of this type is seen in Fig. 3. See also Figs. 4, 5 and 6.

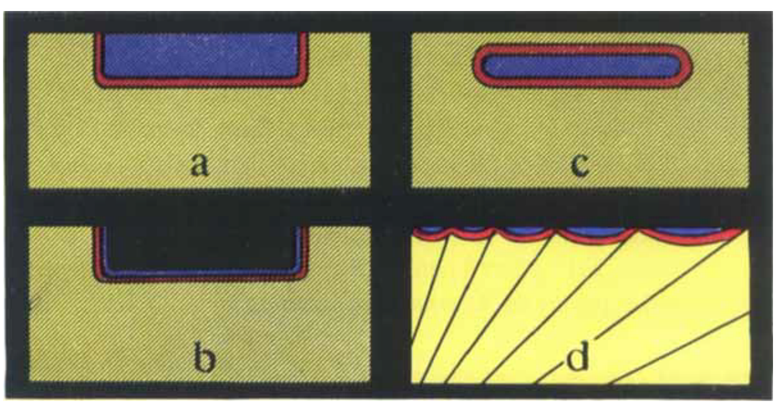
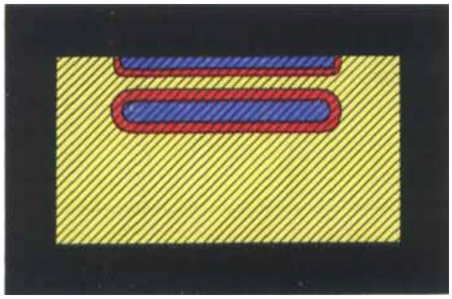


Fig. 2. Schematic drawing from: *Hals, Mörch and Sand*, 1955. Types of defect. Polarized light (compensator). Distilled water. The prisms oriented with their longitudinal axes diagonal through the positive quadrants. Yellow = —, blue = +, red = o, a: outer spot (Ia); b: outer spot (Ib); c: inner spot (II). Prisms in a, b, and c drawn as faint lines. d: outer spot at very early stage. Relations to striae of Retzius. Prisms not drawn.



Simultaneous occurrence of inner and outer spot.
Fig. 3.

The classification of the differences between the two halves was based on the following principles (see also Figs. 4 and 5):

ONE OF THE HALVES	THE OTHER HALF
MARKED DIFFERENCE	
Broad outer spot with or without cavity	No spot at all or initial inner spot
Broad inner spot	No spot at all
Broad inner spot + outer spot	No spot at all
SLIGHT DIFFERENCE	
Inner or outer spot	Inner or outer spot
(Difference between the two halves only one of degree)	
Inner + outer spot	Inner + outer spot
(Difference between the two halves only one of degree)	
Broad outer spot	Inner spot of average breadth

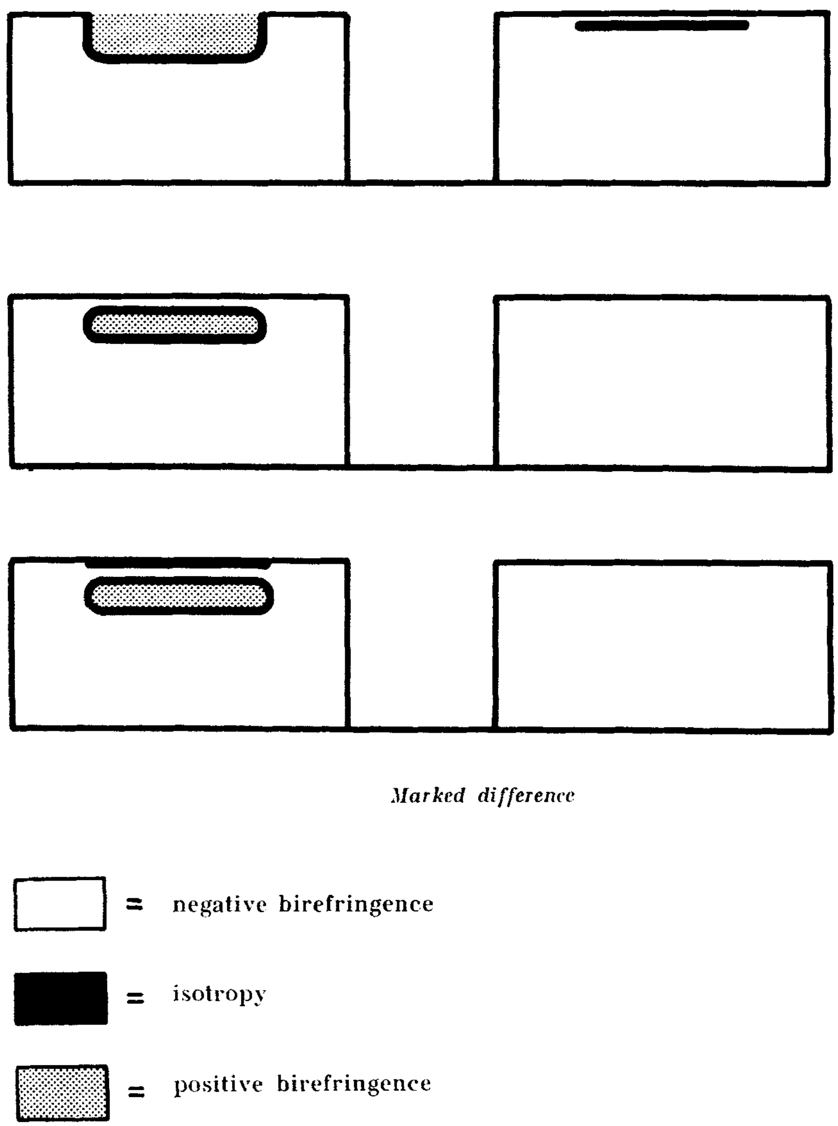
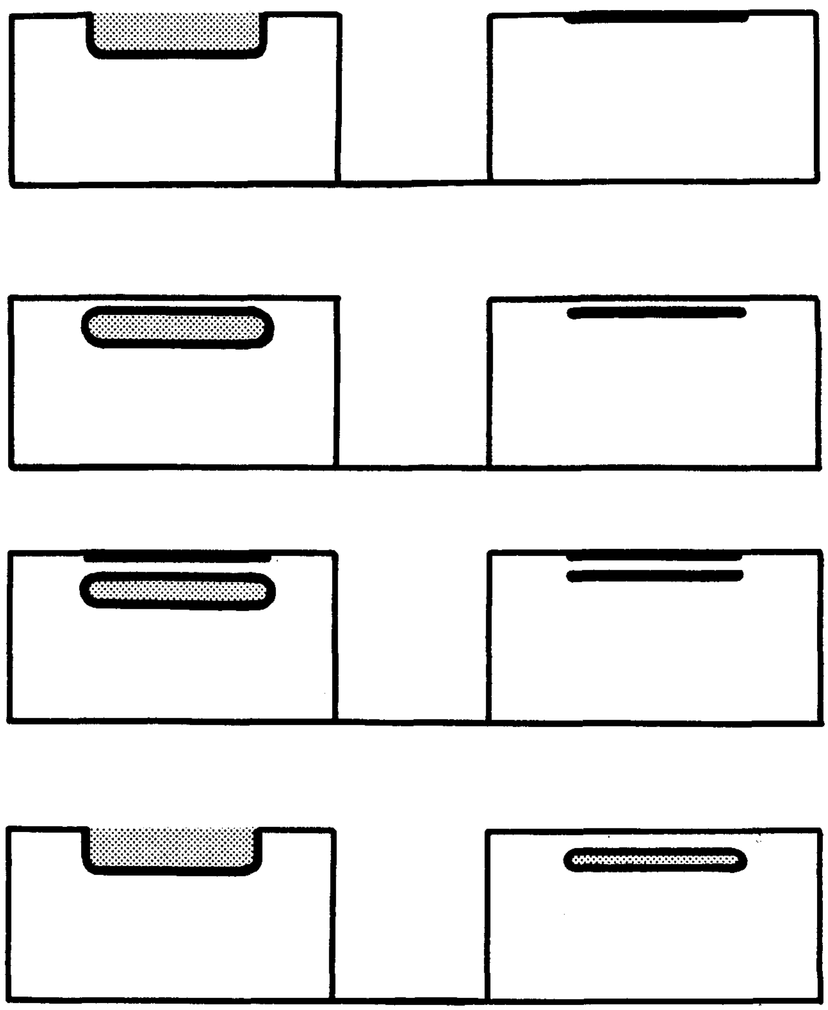

Marked difference
= negative birefringence
= isotropy
= positive birefringence

Fig. 4.



Slight difference

Fig. 5.

Other combinations have not been taken into consideration.

The difference is expressed as positive if it favours the treated half and negative if it favours the control half.

No difference: Outer or inner spots of the same appearance on both halves or no spot at all on any of them.

Aqueous solutions of the following chemical compounds (with varying concentration and pH) were used for the application: —

1) Sodium fluoride.
2) Sodium fluoride + stannous chloride.
3) Ferric chloride.
4) Aluminium sulphate.
5) Sodium oxalate.

It was of interest to study whether or not any of the fluorides caused detectable changes in the outer zone of the enamel. Therefore, ground sections were prepared from teeth which had been treated with the chemical compounds only. An examination of these sections in polarized light revealed no changes.

RESULTS

Sodium fluoride:

A 2 % solution of sodium fluoride, pH 6.65, was applied in 15 experiments. The time of application varied from 10 to 25 minutes. In all cases, outer or inner spots appeared on both halves. No difference could be seen in 13 cases. One case presented a slight positive difference and one case a slight negative difference. A 1 % solution of sodium fluoride in lactate buffer, pH 4.22, was applied in 5 experiments. No difference was found in 4 cases, while one case showed a slight negative difference.

Sodium fluoride combined with stannous chloride:

a) Ratio F : Sn = 4 : 1.

41 experiments were performed with solutions containing fluorine and stannous ions in the ratio 4 : 1. The concentration of NaF varied from 0.25 M to 1.25 M. In 26 cases no difference was found. 13 cases showed slight positive difference, while in 2 cases a slight negative difference was observed.

b) Ratio F : Sn = 2 : 1.

8 experiments were performed with 0.02 M stannous chloride solution containing sodium fluoride, the ratio F : Sn being 2 : 1. The pH was adjusted to 2.8 with hydrochloric acid. No difference could be seen in any of the cases.

Ferric chloride:

0.2 M ferric chloride, pH 2.1, was applied for 19 minutes in 2 experiments. A marked negative difference was observed in both cases. It should be mentioned that this solution caused a macroscopically detectable decalcification of the enamel surface.

Aluminium sulphate:

In 5 experiments 5 % $Al_2(SO_4)_3$ was applied for 10—12 minutes. Outer or inner spots appeared in all cases. In 3 cases there was no difference, one case showed a slight positive difference and one case a slight negative difference.

Sodium oxalate:

2 experiments were performed with 1 % sodium oxalate. The application time was 7 minutes. No difference was found. All matching halves presented outer spots of the same magnitude.

DISCUSSION

Sodium fluoride, aluminium sulphate, ferric chloride, sodium oxalate, and sodium fluoride combined with stannous chloride in the ratio F : Sn = 2 : 1 did not produce any detectable increase in the resistance of enamel to the lactate buffers. When sodium fluoride was combined with stannous chloride in the ratio F : Sn = 4 : 1, a slightly increased resistance could be detected in 20 % of the cases, which, however, only can suggest a highly uncertain trend. These results do not correspond with the results of previous laboratory experiments. The discrepancy may depend on the fact that the present method demonstrates the very localization of the loss of minerals, i.e. in the interprismatic substance and prism sheaths only or simultaneously in the prism bodies, in the outer zone of the enamel or in the area just below the surface. This method thus offers a qualitative evaluation.

while earlier methods are based on quantitative registration or visual examination of questionable accuracy.

Further, the findings are not in agreement with results obtained clinically by topical application of sodium fluoride and stannous fluoride. *Ceteris paribus* clinical results are more conclusive than laboratory experiments. Information obtained in laboratory experiments, however, may be valuable in the evaluation of the caries inhibiting effect of different substances used for topical application, as well as for the understanding of the chemical processes involved. Therefore, such experiments may form a basis for further investigations *in vivo*.

II

EXPERIMENTS WITH A MODIFIED METHOD

THEORETICAL BASIS FOR MODIFICATION OF THE METHOD

The most reliable information can be obtained from laboratory experiments which are performed under conditions resembling those in the mouth as much as possible. Compared to conditions *in vivo* the following discrepancies are found in the method described above: —

When topical application of a chemical compound has been performed clinically, a certain period of time will usually elapse before the patient eats, i.e. before the treated enamel surfaces are contaminated with food-stuffs which can be fermented to acids. Consequently, the enamel is exposed to neutral saliva for different lengths of time. This must be assumed to have certain physico-chemical consequences, some of which may favour the establishment of an increased acid resistance, while others may be unfavourable.

If compounds are precipitated on the enamel from acid solutions, they may be hydrolyzed in the saliva. This hydrolysis may reduce the building of acid-resistant complexes in the surface of the enamel. On the other hand, it is possible that precipitates deposited from acid as well as from neutral solutions are unaffected by hydrolysis and, therefore, get time to become better crystallized in the presence of the calcium and phosphate ions of neutral saliva.

Most certainly the saliva (under unfavourable conditions) can also affect newly precipitated compounds by the formation of protein-complexes, thus possibly rendering these precipitates more soluble. Further it may be mentioned that the redox system of the saliva is important when iron and tin compounds are employed (*Torell,* 1955).

Accordingly, the influence of saliva must be taken into consideration also when we are dealing with laboratory experiments. Therefore, it seems logical to place the teeth in neutral saliva during a certain period of time immediately after the topical application.

In the introductory experiments the acid resistance of the enamel surface was tested with sodium lactate buffers. During decalcifying processes in the mouth, however, calcium and phosphate ions are always present, which modify or counteract the dissolution of the enamel. Thus it must be assumed that the action of the lactate buffer solutions on the experimental areas has been definitely stronger than would be possible in the mouth. Most likely the laboratory method of testing the acid resistance of the experimental areas could be improved by the use of acid solutions containing calcium and phosphate ions in concentrations of similar strength as in the saliva. The best way to obtain this is presumably to carry out the experiment in acidulated saliva.

A vast number of publications indicate that sugars are caries-activating (*Miller,* 1892, *Easlick,* 1948, *Gustafsson et al.,* 1954, Sugar and Dental Caries: J. Am. Dent. Ass. *47:* 387, 1953). Investigations *in vivo* have demonstrated that sugars usually are rapidly fermented to acids in the mouth which results in a drop of the pH to 4 in the dental plaque as well as in the saliva (*Stephan,* 1944 and 1948).

There has been some discussion as to the "critical pH-value" below which the enamel is decalcified *in vivo,* but according to experiments *in vitro* it seems to be about 4.5—5.5 (*Enright, Friesell* and *Trescher,* 1932, *Ericsson,* 1949, and *Graf,* 1953). Thus, by means of sugars it seems possible to establish pH-values in the dental plaque low enough to dissolve the enamel *in vivo.* This indicates that the acidulated saliva would have a pH-value of 4—4.5.

Torell (1955) emphasizes the role of the caries activating, reducing and complex forming capacity of sugars and products formed from sugars by the enzymatic activity of the microorganisms in the mouth. This factor is allowed to act on the experimental areas if the teeth are incubated for some time in saliva mixed with sugars. Thus, it seems necessary to allow enough time for a decrease in the pH-value to 4—4.5, and, subsequently, to keep the teeth in this milieu long enough for detectable decalcification of intact enamel to appear. Therefore, the method used in the introductory experiments should be modified so as to establish a closer resemblance to the conditions in the mouth.

In the introductory experiments the effect of the chemical treatment of the enamel has been registered by comparing the acid resistance of one treated and one untreated area of the same tooth. Positive conclusions drawn from such a comparison are justified provided the acid would have acted in the same way on both areas if none of them had been treated previously.

As the effect of the chemical treatment has been determined by comparing the acid resistance of treated and untreated areas, correct conclusions can only be drawn if the chemical composition of the surface layers of the compared areas was initially the same.

It is maintained that the acid resistance of the enamel surface increases with age (*Dobbs*, 1932, *Brudevold*, 1948, *Sullivan*, 1954). Several authors report that young enamel is more easily stained and penetrated by certain dyes than is old enamel (*Gustafson*, 1945, *Atkinson*, 1947, and *Sognnaes & Wislocki*, 1950). *Atkinson* (1947), among others, stated that young enamel is more easily penetrated by inorganic ions than is older enamel. It is reported that increased resistance to dental caries is established during a period of non-cariogenic dietary regime (*Sognnaes*, 1948, *Quensel & Gustafsson*, 1954, *Schultz*, 1935, *Shaw*, *Elvehjem* and *Phillips*, 1945, *Muhler*, 1954, *Fanning*, *Shaw* and *Sognnaes*, 1954, *Volker* and *Klapper*, 1952). Thus, it can be concluded that after tooth eruption the physico-chemical characteristics of the surface layers of the enamel are modified. Consequently, in experiments of the type described in the present paper comparable conditions can be obtained by using areas which during the same period have been exposed to the influence of saliva, food-stuffs and other factors present in the mouth of the same individual. This condition seems to be fulfilled if the experimental areas to be compared are located on the same tooth.

Recent investigations have shown that corresponding areas of contralateral pairs of teeth present similar structural conditions (*Anna-Greta Gustafson,* 1955). However, when the mesial and distal halves of the buccal surface of premolars are compared, no identical structural similarity has yet been found. Therefore, the results presented above may have been influenced by structural differences between the halves which have been compared. Accordingly, it would have been more adequate to use corresponding areas from contralateral pairs of teeth, which had been erupted equally long. However, it was found almost impossible to obtain a great number of experimental areas in this way. The material available for the experiments consisted of teeth extracted in the course of orthodontic treatment in order to eliminate crowding. In cases of crowding, however, homologous teeth rather seldom were found to erupt simultaneously. Hence it was difficult to obtain homologous teeth with presumably the same chemical composition of the enamel surface layers. The difficulties of procuring a material of this kind has been mentioned previously by *Syrrist* (1949). He emphasizes that the use of a pair of homologous teeth, for comparing the effects of different topically applied solutions, necessarily demands that the two teeth have been exposed to the saliva for the same length of time.

The disadvantages of not using homologous teeth may to some extent be eliminated if the applications are made alternately on the mesial and distal halves of the buccal areas of the teeth, as done in the introductory experiments. Therefore, it was decided that this method should be used in all of the following experiments, and also that the buccal surfaces should be carefully examined macroscopically and with a dissecting microscope before application in order to avoid areas with hypocalcifications or incipient caries.

The varying results of the introductory experiments indicate that a great number of teeth must be used if reliable information is to be expected.

In a special study the writers found that inner and outer spots of the same types appeared when dental enamel was incubated in saliva-sugar solution as when exposed to lactate buffers (pH 5.25—4.12). As already mentioned, however, the simultaneous occurrence of inner and outer spots was more frequent in the saliva-sugar experiments. (The results of this study will be presented in detail in a subsequent issue of this journal).

MATERIAL AND METHOD

The method of the introductory experiments was used with the following modifications:

1) The application time was limited to 10 minutes.

2) No wax tubes were mounted over the experimental areas.

3) After the application of the compounds, the experimental halves were submitted to fresh saliva for one hour.

4) After the exposure to fresh saliva the teeth were placed in saliva containing 10 % sucrose and then incubated at 37° C for 18—24 hours.

Fig. 6. Experiment: $SnCl_2$ + NaF, "matured" for 24 hrs., pH 2.97.

(a) Survey picture. Untreated half to the left of the sulcus, treated half to the right. Decalcification to a higher degree on untreated half.

(b) From the untreated half. Both inner spot and outer spot. In the area between these, the enamel has maintained a weak negative birefrigence. Effect of acid is also seen in the enamel just beneath the inner spot. Here the interprismatic substance, perhaps the prism sheaths too, are affected.

(c) From the treated half, narrow inner spot. As in (b) areas with affected interprismatic substance, perhaps prism sheaths too, are seen.
The case is recorded as "slight positive difference".

Legend
Figs. 6—8
D — dentin
E — enamel
O — outer spot
I — inner spot
+ — positive birefringence
o — isotropy
÷ — negative birefrigence
R — Striae of Retzius
A — affected area of the enamel beneath inner spot

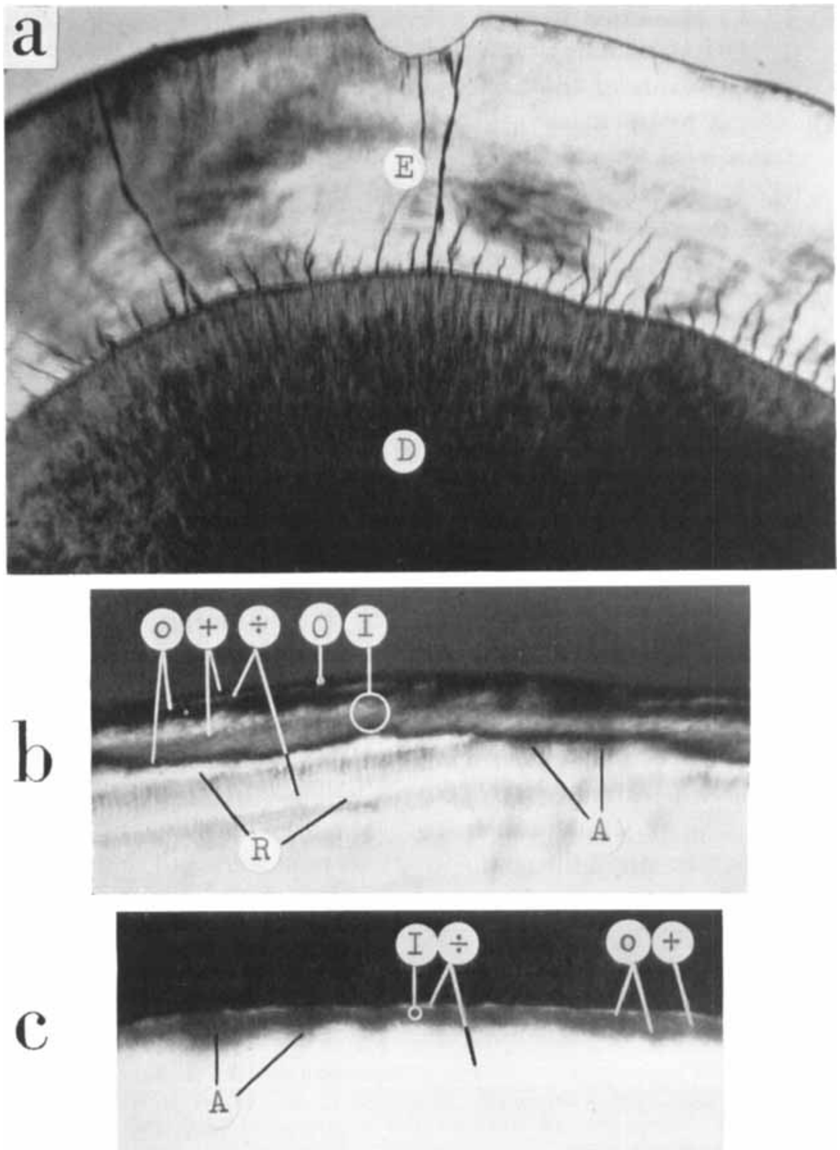


Fig. 6.

The following solutions were applied:

I) 0.1 M sodium fluoride — pH 6.8.

II) 0.02 M stannous chloride + 0.04 M sodium fluoride.

The pH-value of the latter solution was adjusted to 2.8 with the aid of hydrochloric acid. The solution was allowed to stand and was used for new applications at intervals of 1—3 days.

III) 0.1 M ferric chloride + 0.1 M ferrous chloride + 0.2 M sodium fluoride.

pH was adjusted to 2.8 with hydrochloric acid. New applications were made at the same intervals as with solution II.

RESULTS

Sodium fluoride experiments

16 experiments were performed with NaF. All areas presented outer or inner spots. No difference was found in any of the cases.

Tin fluoride experiments

With freshly prepared solutions 8 experiments were performed. All areas presented outer or inner spots. No difference was found.

16 applications were made with solutions, which had "matured" for 1—20 days. In 3 areas outer or inner spots of the same size appeared. In 11 cases a slight positive difference was found (Fig. 6), while two cases gave a marked positive difference (Fig. 7). The pH-value of the solutions had decreased to 2.6—2.5 during the "maturation".

Fig. 7. Experiment: $SnCl_2$ + NaF, "matured" for 24 hrs., pH 2.43.

(Legend see Fig. 6.)

(a) Survey picture. Untreated half of experimental area to the left of the sulcus, treated half to the right. In the lower left corner is seen part of drilled hole. High degree of decalcification on untreated half, while the other half is apparently intact.

(b) From the untreated half at higher magnification. Inner spot together with very narrow outer spot. In the area between, the enamel has maintained its negative birefrigence.

(c) From the treated half at the same magnification.
The enamel intact.
The case represents "marked positive difference".

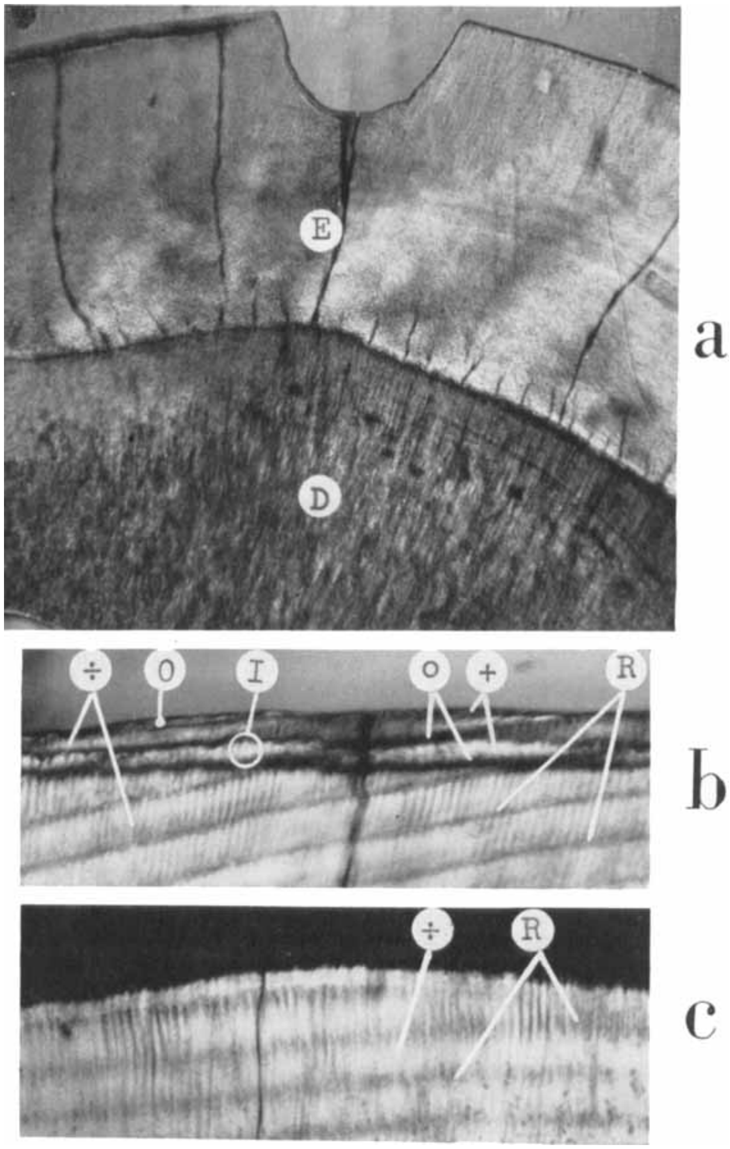


Fig. 7.

Iron fluoride experiments

In 6 experiments with freshly prepared solutions all areas showed outer or inner spots. No difference was noted.

After "maturation" for 4—20 days 3 cases presented a marked positive difference (Fig. 8), 7 cases a slight positive difference, and 2 cases no difference. The pH-values of the solutions decreased to 2.6—2.3.

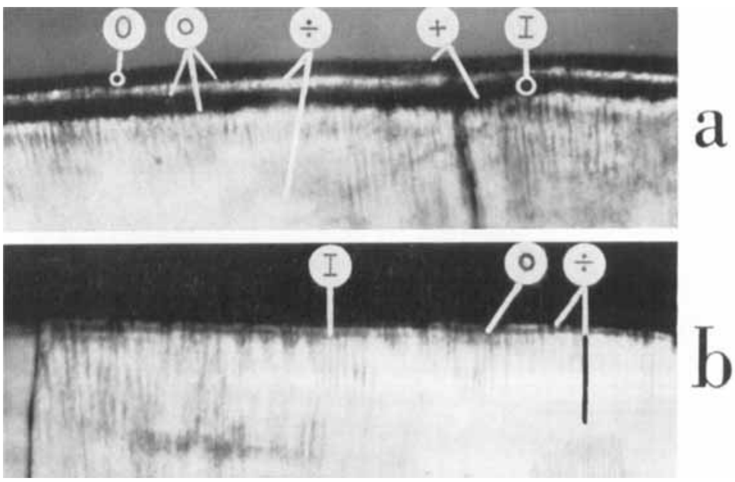


Fig. 8. Experiment: $FeCl_3 + FeCl_2 + NaF$, "matured" for 10 days, pH 2.30.

(Legend see Fig. 6.)

a) From the untreated half. Inner spot together with outer spot. In the area between these, the enamel has maintained its normal negative birefringence. (b) From the treated half. Very slight effect. Initial inner spot as a faint stripe. The case is recorded as "slight postitive difference", according to the definition employed. (Actually the difference is more than slight without, however, justifying the term "marked difference").

DISCUSSION

The results indicate that some of the iron and tin fluoride solutions have increased the resistance of the enamel surfaces to attacks of the kind induced in the present investigation. Similar results have not been obtained with sodium fluoride solutions and freshly prepared tin or iron fluoride solutions.

It is not easy to explain why the stannous fluoride or the iron fluoride solutions needed several days of maturation to be able to increase the acid resistance of the enamel. This rather puzzling fact may depend on an altered relation between the concentrations of the ions Sn^{+2} and Sn^{+4}, or between the ions Fe^{+2} and Fe^{+3}, caused by oxidation. It is also possible that the effect depends on an increase of the acidity of the solutions caused by hydrolysis after oxidation. If the action of the matured solution were to be fully explained, more experiments would be needed with due regard to the chemical behaviour of the tin fluorides and the iron fluorides.

SUMMARY

In the present paper a method is described, which seems to be a useful implement for the evaluation of the acid resistance established *in vitro* after chemical treatment of enamel surfaces.

After introductory experiments the following procedure was used: The buccal areas of newly erupted teeth were divided into two halves. One half on each tooth was treated for 10 minutes with a solution containing either sodium fluoride (pH 6.8), stannous chloride and sodium fluoride (pH 2.8), or ferrous chloride, ferric chloride and sodium fluoride (pH 2.8). The other half of the area was used as a control. After the application the teeth were placed in fresh saliva for one hour and incubated for 18--24 hours at 37° C in saliva containing 10 % sucrose. Ground sections were then prepared and examined in polarized light.

The degree of demineralization of the experimental areas was evaluated by registering the appearance of outer or inner spots (*Hals, Mörch* and *Sand,* 1955). The action of the chemical treatment was determined by comparing the treated and the untreated halves.

The investigation showed that sodium fluoride and newly prepared "tin" and "iron" fluoride solutions seemed to be without effect. After storing for 1—20 days, however, the tin and iron fluoride solutions obviously increased the resistance of the enamel.

The experiments have been performed with the purpose of

working out a suitable method for a detailed study of some of the problems involved in topical application of substances with caries reducing effect. Such investigations are in progress and will be reported later.

RÉSUMÉ

EFFETS DE L'APPLICATION TOPIQUE D'AGENTS SUR L'ÉMAIL· I MÉTHODES POUR EXPÉRIENCES IN VITRO.

Dans cette étude on a décrit une méthode qui pourra devenir utile à l'évaluation de la résistance aux acides, établie *in vitro* après traitement chimique de l'émail dentaire humain.

Après des essais préliminaires on a utilisé le procédé suivant: Les surfaces vestibulaires de dents récemment poussées furent divisées en deux par un sillon. Une moitié fut soumise pendant 10 minutes à l'action d'une solution contenant soit du fluorure de sodium (pH 6.8), du chlorure stannique et du fluorure de sodium (pH 2.8), soit du chlorure ferreux, du chlorure ferrique et du fluorure de sodium (pH 2.8), l'autre moitié servant de contrôle. Après l'application les dents furent mises dans de la salive fraîche, où elles demeurèrent pendant une heure, puis mises à tremper pendant 18—24 heures, à 37° C, dans de la salive contenant 10 % de saccharose. Des coupes histologiques, usées à la meule, furent préparées et examinées en lumière polarisée.

Le degré de déminéralisation des plages d'essai fut évalué d'après l'apparition de taches externes ou internes (*Hals, Mörch* et *Sand* 1955). L'effet du traitement chimique fut déterminé par une comparaison les moitiés traitées et non-traitées.

La recherche montra que le fluorure de sodium et les solutions fluorurées fraîches avec du fer ou de l'étain semblent être sans effet. Pourtant, si elles sont emmagasinées de 1 à 20 jours, elles ont apporté une augmentation manifeste de la résistance de l'émail dentaire.

On a fait ces essais avec l'intention d'élaborer une méthode appropriée à l'étude détaillée de quelques-uns des problèmes soulevés par l'application topique de substances ayant un effet réduisant la carie. De nouvelles recherches sont en cours d'exécution et l'on en rendra compte plus tard.

ZUSAMMENFASSUNG

DIE WIRKUNG VON LOKAL APPLIZIERTEN LÖSUNGEN AUF DEN SCHMELZ.
I. METHODEN FÜR EXPERIMENTE IN VITRO.

In der vorliegenden Arbeit wird eine Methode beschrieben, die eine wertvolle Hilfe sein kann bei der Bestimmung, der *in vitro* nach chemischer Behandlung erreichten Säurewiderstandsfähigkeit der Schmelzoberflächen.

Nach einleitenden Versuchen ging man folgendermassen vor: Die buccalen Flächen von frisch durchgebrochenen Zähnen wurden in zwei Hälften geteilt. Die eine Hälfte eines jeden Zahnes wurde für 10 Minuten mit einer Lösung behandelt, die entweder Natriumfluorid (pH 6,8), Zinnchlorid und Natriumfluorid (pH 2,8), oder Ferrochlorid, Ferrichlorid und Natriumfluorid (pH 2,8) enthielt. Die zweite Hälfte der Flächen wurde zur Kontrolle benutzt. Nach diesem Vorgehen wurden die Zähne für eine Stunde in frischen Speichel gelegt und anschliessend für 18—24 Stunden bei 37° C in einer Speichellösung mit 10 % Sacharosezusatz in einem Brutschrank aufbewahrt. Dann wurden Schliffe hergestellt und im polarisierten Licht geprüft.

Der Demineralisationsgrad von diesen Versuchsflächen wurde durch Registrierung der auftretenden äusseren und inneren Flächen bestimmt (*Hals, Mörch* u. *Sand,* 1955). Die Wirkung dieser chemischen Behandlung wurde festgestellt, indem man die behandelten Flächen mit den unbehandelten verglich.

Die Untersuchung zeigte, dass Natriumfluorid und frisch zubereitete "Zinn"- und "Eisen"-fluoridlösungen ohne Wirkung zu sein schienen. Die 1—20 Tage alten Zinn- und Eisenfluoridlösungen erhöhten jedoch auffallend die Widerstandsfähigkeit des Schmelzes.

Die Untersuchungen wurden in der Absicht durchgeführt, eine Methode für ein eingehendes Studium einiger Probleme auszuarbeiten, die sich mit der lokalen Applikation von kariesverhütenden Substanzen befassen. Weitere Untersuchungen sind im Gange und werden später veröffentlicht.

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