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# A Study of the Cleaning Methods on Pits and Fissures of Immature Permanent Teeth Part-II Elementary analysis of the contents in fissures by using EMPA

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**Summary**

The application of fissure sealants have been highly appreciated to prevent the development of caries in immature permanent teeth such as first molars immediately after their eruption. However, the sealant often breaks and peels off due to the insufficient cleansing of the surface and pits and fissures of the teeth. We newly developed diamond fixed scratch point (DFSP) for the cleansing of pits and fissures of immature permanent teeth.

In this study we aimed to have good prognosis of the condensation of fissure sealant and to suppress the progress of early fissure caries, and made a comparison of this method with conventional methods using brushcone and air-flow in term of the components of fissure debris after cleansing. The effects of cleaning for the three cleaning methods were examined comparatively by usting EMPA. The results obtained were as follows :

1. It was difficult to remove the contents in deep narrow fissures of types I and IK by the methods using brushcone or air-flow. Cleansing effect could not be recognized in the narrow base, for debris and organic residue were found.

2. DFSP developed by authors removed all of the organic debris in the fissures to result in excellent cleansing effect.

3. It was confirmed that extremely mild mechanical cleansing by use of DFSP brought good cleansing effect in deep narrow fissures which seemed to be unable to be cleansed sufficiently by the conventional methods.

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## Introduction

Fissure sealants are widely used to manage pits and fissures of immature permanent teeth which are apt to be attacked by dental caries[18], and it is reported that they suppress the development and progress of caries[14].

The efficacy of sealants is evaluated by the rates of its retention and suppression of caries. The prognosis of the application of them depends on how long they are retained in the pits and fissures in good condition. However, there are reports which showed their low rates of prolonged retention in pits and fissures due to their fracture or dislodging[19,7,8].

Shapes of pits and fissures, existence of Nasmyth membrane on the enamel surface immediately after the eruption of the teeth[5], and extent of cleansing of the fissures and decalcification effect of acid etching treatment as the pretreatment of the application of sealants are the factors to decide prognosis. Particularly, it is impossible to cleanse sufficiently the deep and narrow fissures of types I and IK[15] and etching does not exert any effect. Thus the sealant cannot penetrate into the base of the fissure, and acid resistant Nasmyth membrane prevents the formation of etched pocket. These cause the fall of the rate of retention of the sealant.

Many reports have been published on various methods for cleansing pits and fissures including the chemical cleansing method with NaOCl, and its combined use with an ultrasonic vibrator. It was reported that these methods were effectively applied for cleansing the fissures of types U and V[15] having simple shapes[1], but no reports are available on simple and effective methods for cleansing fissures of types I and IK which are narrow and deep. In part I of this study, we made a comparison of etching effect and penetration of sealants into the pits and fissures after cleansing through the observation of SEM, using the methods of brushcone, air-flow and diamond fixed scratch point (DFSP) for cleansing immature permanent teeth having deep narrow fissures of types I and IK[21]. We found that brushcone method was extremely insufficient to remove the characteristic contents found in fissures, which did not show the extent of penetration of the sealant. Even on the surface around the opening of the fissures, surface layer of enamel was not exposed and no enamel rod could be found. Instead, organic debris such as dental cutilce could be recognized. Air-flow method removed the organic debris around the opening of the fissures, and honeycomb structure, though neither regular nor uniform, could be observed after etching was made. However, only comparatively soft debris was removed, indicating that no sufficient cleansing effect was obtained.

In this study we aimed to make a quantitative observation of the extent of cleansing of immature permanent teeth using the methods of brushcone, air-flow and DFSP. Elementary analysis was made on the debris in the fissures with an electronic probe x-ray micro analyzer (EPMA) to make a comparison of the effects of each method.

## Materials and Methods

Materials : The subjects were the first and second premolars extracted from upper and lower jaws for orthodontic treatment which were sound or on early stage of caries and whose root was not complete. Cleansing of the surface and fissures of the teeth was made by the methods of brushcone, air-flow and DFSP attached to the tip of an ultrasonic cleansing vibrator as shown in Fig. 1. The extent of cleansing was observed by dividing a tooth to the buccal side and lingual side serving as experimental side and control side.

Experiment : Fissures of the both experimental and control groups were cleansed as cleanly as

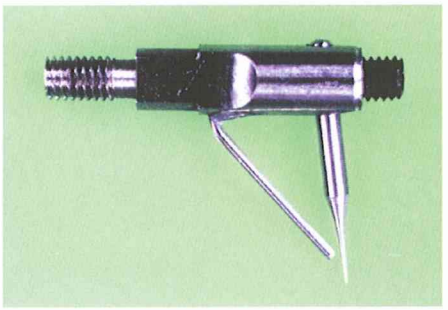


**Fig. 1.** Diamond Fixed Scrach Point (DFSP)

possible with a dental explorer (# 23BS). The surface of the teeth of control group I was cleansed for 60sec under pouring water, using brushcone attached to contra-angle handpiece. The surface of the teeth of control group II was cleansed for 60sec with an Air-flow from Shofu Company, and linsed with sufficient water to remove the abrasive.

Pits and fissures of the teeth of experimental group were cleansed with DFSP attached to an ultrasonic vibrator (Solfy from Morita Company) under pouring water.

The fissures of all of the samples of the experimental and control groups were cut to the buccal and lingual side along tooth axis to make sliced specimen. The specimen were dehydrated with alcohol and dried with liquid carbon dioxide with a critical point drying apparatus. Then, the specimen were embedded with epoxy resin and subjected to vapor deposition with carbon. The specimen thus prepared were subjected to elementary analysis with a wave length disparsive spectrometer (WDS) to investigate the distribution of the elements contained with contour map method. Analysis was made at an acceleration potential of 20KV, beam current of $1\times10^{-8}$A. Measurement was made on 26,000 points in the area of $400\times800\ \mu m^2$ to make a contour map. JCXA -733X micro analyzer from Nippon Electronic Co. Ltd. was used, which was equipped with a computer controlled system.

## Results

1. Observation by SEM

Figs. 2-a, b, and c show SEM images of the fissures after cleansing by the methods of brushcone, air-flow and DFSP. Fig. 2-a shows the fissure cleansed by brushcone method and it could be observed that there was a structure which seemed to be organic debris from the opening to the base of the fissure.

Fig. 2-b shows the longitudinal sections of a fissure cleansed by air-flow method. Quantitative decrease of organic debris could be recognized in comparison with the figure shown in Fig. 2-a. However some residue could be found at the bottom and just below the opening of the fissure.

No residue could be recognized in Fig. 2-c showing the result of cleansing by DFSP method.

2. Elementary analysis with EMPA

Figs. 3-a, b, and c, Figs. 4-a, b, and c, and Figs. 5-a, b, and c show the distribution of Ca, Mg and S which are specific components of dentin on the longitudinal section of the fissures cleansed by the methods of brushcone, air-flow or DFSP respectively.

Fig. 3-a, b, and c show the result of cleansing by brushcone method. It was found that the fissure

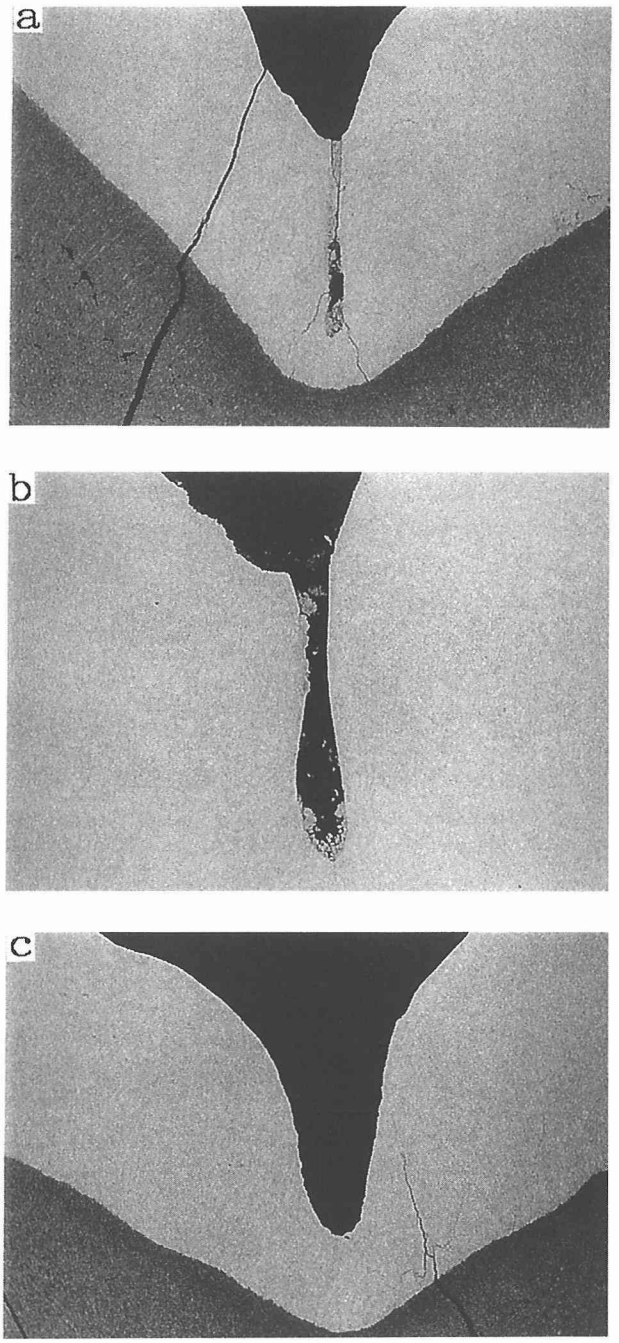
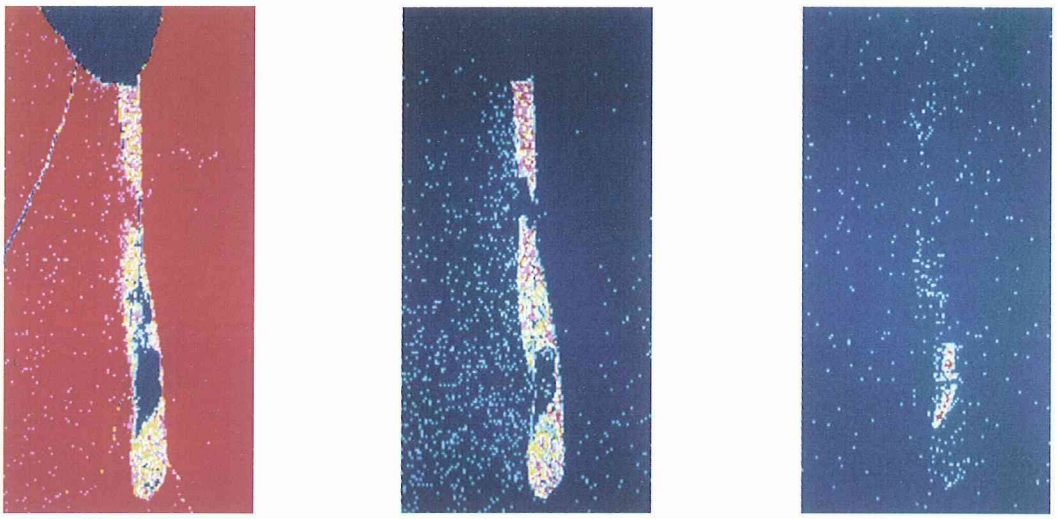
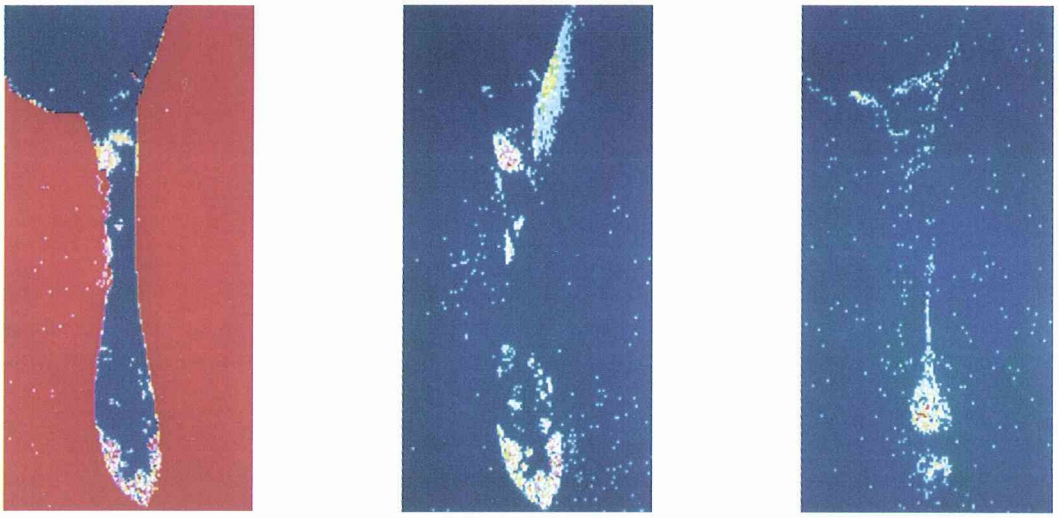



**Fig. 2.** SEM photographs of pits and fissures:
(a) cleaned by brush-cone;
(b) cleaned by air-flow;
(c) cleaned by DFSP.



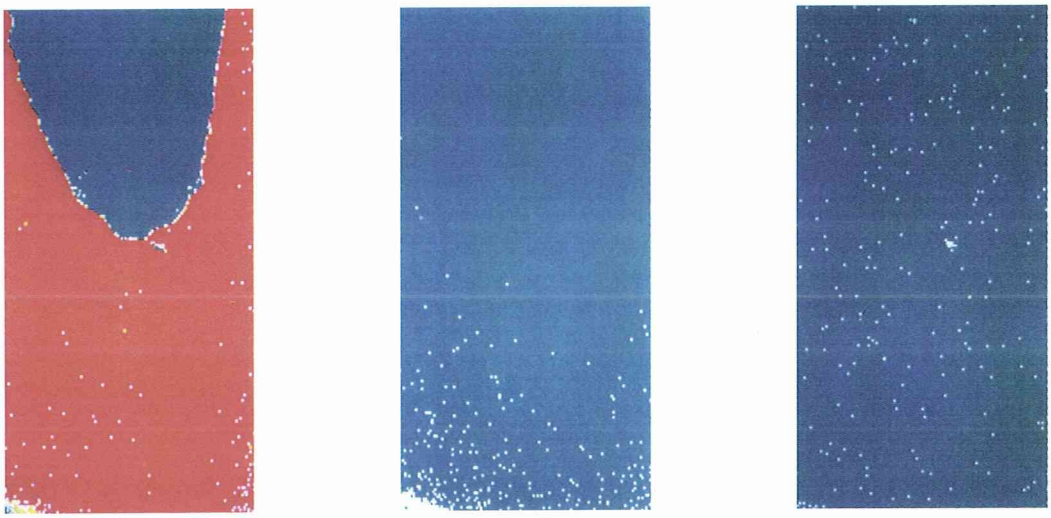
a）Ca　　b）Mg　　c）S

**Fig. 3.** Distribution of element contents by EMPA.
(cleaned by brush-cone)



a）Ca　　b）Mg　　c）S

**Fig. 4.** Distribution of element contents by EMPA.
(cleaned by air-flow)



a) Ca b) Mg c) S

**Fig. 5.** Distribution of element contents by EMPA.
(cleaned by DFSP)

from the opening to the bottom was filled with a structure which looked like organic debris and that a lot of Mg and S was present. This shows or indicates that little cleansing effect could be obtained by brushcone method.

Figs. 4-a, b, and c show the longitudinal section of a fissure by air-flow method. Compared with the results shown in Figs. 3-a, b, and c, quantitative reduction of organic debris could be recognized, but some content could be found at the bottom and just below the opening of the fissure. A small amount of Ca was detected in the debris at the bottom, and a lot of Mg and S except for Ca was also detected.

With DFSP shown in Figs. 5-a, b, and c, the fissure was cut in a spitz shape from the opening to the base of the fissure and the debris peculiar to the fissure could not be found at all. All of the content in the fissure had been removed. No existence of Mg and S except for Ca could be recognized.

Materials used for the experiment shown in the figures above mentioned were immature permanent teeth whose pits and fissures were diagnosed to be sound or in the condition of $C_0$ or $C_1$ by inspection.

## Discussion

It is said that annual incidence of caries in pits and fissures is about 6 times as high as that on approximal surfaces. Hyatt[9,10] said that pits and fissures are not formal grooves as developmental groove in term of morphology, but that they are formed as a result of incomplete concrescence between developmental lobes, indicating high possibility of the development of caries. In fissures microorganisms grow and colonies are formed through the deposition of dental calculus and mutin-like substances, and entrance of food residue. The internal cavity of a fissure is very narrow

and deep, resulting no self-cleansing effect, and it cannot be expected that it is cleansed with an artificial method such as using a brush. Therefore, it can be said that the internal cavity of a fissure is an optimum area for the development of caries and that pits and fissures may have a risk for a local factor to develop caries.

Jensen et al[13] reported that in vivo the number of microorganisms decreased in the pits and fissures sealed for one year. They also showed that acidogenic bacteria could survive and often kept their activity even after they were sealed for one year. They recommended to remove the content in fissures as much as possible. Since Buonocore[2] applied sealants for the first time to treat fissure caries, sealants have been widely used in general clinic with the progress of high molecular materials. However, it is thought that if a part of sealant is broken and removed growth of microorganisms will cause induction and development of caries with frequency.

Tayler et al[19], Chow[4], and Bowen[3] pointed out that the existence of debris in pits and fissures with complex shapes has influence on etching effect and prevents the penetration of sealant into them, and reported that the extent of the penetration of the sealant into the pit and fissures will be a major factor to decide the prognosis. Then, it is thought that successful application of a sealant depends on how the surface and pits and fissures of a tooth are cleansed as pre-treatment. Various cleansing methods have been discussed these years including chemical cleansing method, combined method of chemical and ultrasonic vibrator[14,1,11]. These methods can afford excellent cleansing effect on the fissures of types V and U. However, no sufficient effect have not been obtained to cleanse those of types I and IK due to the difficulty to remove the content in the narrow part of the fissures.

In general clinic an explorer and brushcone method have been usually used to cleanse pits and fissures. Our experimental result showed brushcone method can cleanse the surface of the tooth around the opening of a fissure, but that organic debris in the fissure was recognized. This meant that the specific organic content in the fissure could not be removed sufficiently to apply a sealant. Air-flow method removed most of the organic debris around the opening of the fissure, but the sufficient cleansing effect on the contents of the fissure could not be obtained with the restriction to comparatively soft debris. In contrast to these methods, DFSP exerted excellent cleansing effect without cutting enamel of pits and fissures too much. This was attributed to the simplification of the shape of fissures by enlarging the opening of the fissures of types I and IK by 0.1 mm or so, which allowed to remove the content in the narrower part. Furthermore, the expansion of the surface area of the substrate by cutting the narrowed part resulted in etching effect and the sealant could penetrate into the base of the fissures. It was thought that formation is very important to form a tag with large area to reach the base of the fissure was important to improve the rate of the retention of the sealant.

Condensation of sealant has been applied not only as a method to prevent the formation of pits and fissures in the sound tooth but also as a method to suppress the progress of early caries[16,20]. It is difficult to enlarge the pits and fissures on the occlusal surface of immature permanent teeth attacked by early caries to form an occlusal surface. Besides, these teeth have weak physical properties and they are apt to be invaded with decalcification in comparison with mature teeth[17]. Then, the prognosis of condensation of sealant is not good. If plastic filling or cast restoration is applied to the immature permanent teeth with early caries, recurrence of caries in the marging of the teethe treated or the growth of complicated fissures would lead to a problem of the contour of large cavities. It cannot be denied that there is a possibility to damage the shape of permanent

restoration after the completion of occlusal plane. From these viewpoints, there is an opinion that early removal of dentin should be avoided as much as possible from the immature permanent tooth attacked by early caries[20]. It is thought that the application of DFSP to the opening and narrow base of fissures of types I and IK where caries is apt to onset most frequently[15,6] is effective to suppress the progress of the caries, for sealant can penetrate into the base sufficiently by cutting off brittle enamel.

It is said that the mechanism of the onset of caries is closely related to host, microorganisms, food substrate and time[12]. Multiple effective measures should be applied for the treatment of immature permanent teeth which are easily affected by caries at high incidence rates. We think that cleansing of pits and fissures is a positive approach to the factors of, "host" and "microorganisms" of the three major factors by which caries onsets. Various measures including prevention or preventive management should be used to maintain and improve oral health of the children. It is thought that the combined application of sealant with other preventive managements is also very effective to prevent caries.

## Conclusions

At the application of fissure sealant, DFSP (diamond fixed scratch point) we developed was used to cleanse pits and fissures and a comparison was made with other cleansing methods of brushcone and air-flow by making elementary analysis with EPMA.

1. It was recognized the brushcone method was not effective at all to cleanse the debris in pits and fissures.

2. Air-flow method exerted mostly favorable effects in the cleansing of the opening of the fissures, but organic debris could be found in the narrowed part without cleansing effect on fissure.

3. DFSP we developed was effective by exposing fresh enamel on the wall of the fissure.

4. Extremely mild mechanical cleansing method with DFSP was effective to clean se the deep narrow fissure which is difficult to be cleansed with conventional cleansing methods.

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## 抄録：幼若永久歯小窩裂溝の清掃に関する研究
### 第2報　EMPAによる裂溝内の元素分析について

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第一大臼歯を中心とする萌出直後の幼若永久歯に対する齲蝕抑制の手段としてFissure sealantの応用が高く評価されている．しかし，歯面および小窩裂溝部の清掃不良を原因とするsealant剤の破折，脱落も稀ではない．本研究はFissure sealantの良好な予後と初期齲蝕進行の抑制を目的として，幼若永久歯小窩裂溝部の清掃法に著者らが考案したDiamond Fixed Scratch Point（DFSP）を使用し，清掃後の裂溝残遺物成分と，brushcone, air-flowによる従来より行われている清掃法による裂溝残遺物成分について，X線マイクロアナライザー（EMPA）による観察を行い，清掃方法の効果について比較検討を行った．

1．brushcone, air-flowによる清掃法では狭小でかつ深いI，IK型裂溝の内容物の除去は困難であり，特に狭窄部以下にdebrisや有機性残遺物が残留しており裂溝内の清掃効果が認められなかった．

2．本研究で独自に開発したDFSPを使用した清掃法では，裂溝内の有機性残留物は認められず良好な清掃状態を得ることができた．

3．DFSPを用いた極めて軽度な機械的清掃によって，従来の清掃方法では効果が十分ではないと考えられる深達型裂溝の清掃効果が確認された．