HISTOLOGY OF THE FISSURE CONTENTS IN COMPLETELY IMPACTED TEETH

by
Y. AWAZAWA*, K. HAYASHI**, H. KIBA**, I. AWAZAWA***, N. MISUMI**

Key words : Tissue structure - Fissure contents - Completely impacted teeth.

INTRODUCTION

Although opinions vary among scholars, the fissure contents have hitherto been considered to consist of such substances as food debris [2, 15, 16], bacterial colonies [6], dental calculi [5, 17, 19], thickened cuticule [13] or calcified microorganisms [11, 18]. There also are views [8, 12] that the fissure contents differ from tooth to tooth and that they sometimes are made up of food debris and at other times of bacterial colonies, calculi or the residue of enamel organ.

Also, in 1966 AWAZAWA [1] electron microscopically observed the fissure contents of erupted teeth and reported the fissure contents consisted of hypomineralized enamel. Following this report, GWINNETT (1966) [10] also reported that the fissure contents of erupted teeth consisted of hypomineralized enamel as a result of his observations using a polarizing microscope. SOBUE and his collaborators (1974) [20] examined the fissure

* Prof. for Nihon University Research Institute of Science, 4-8-24, Kudan-minami, Chiyoda-Ku, Tokyo, Japan.
Present address : Nihon University School of Dentistry at Matsudo, Matsudo, Japan.

** Department of Pathology, Nihon University School of Dentistry at Matsudo, Matsudo, Japan.

*** Dental practitioner - Okabe-Cho, Ohsato-Gun, Saitama-Ken, Japan.

Bull. Group. int. Rech. sc. Stomat. et Odont. : vol. 31, pp. 99-117, 1988

contents by such methods as polariscopy, microradiography and X-ray crystallography, and also confirmed that the fissure contents of erupted teeth consisted of hypomineralized enamel.

The diverse views of the scholars concerning fissure contents as outlined above are based mostly on their observation of erupted teeth, while no examination has yet been performed with regard to unerupted teeth or completely impacted teeth.

The present authors have made a histological study of completely impacted teeth, prompted by interest as to whether the above-mentioned fissure contents could be observed in the fissures of completely impacted teeth.

MATERIALS AND METHOD

Fourteen lower third molars and one upper first premolar, all completely impacted human teeth, were used in this study. The teeth, after extraction, were fixed with 10 percent neutral formalin.

Of these teeth, ten third molars and one premolar were ground parallel to their long axis both from the mesial and distal sides, each throughout the distribution area of the occlusal sulci. While this grinding was done, the replicas of the cross-sectioned sulci were obtained one by one at an interval of approximately 500 microns. Several replicas were taken from each sectioned sulcus and were examined with both ordinary light microscope and electron microscope by two-step replica method. Meanwhile, ground sections were prepared from the remains of each tooth substance and the occlusal sulci observed light microscopically after staining with hematoxylin and eosin.

With the remaining four third molars, replicas were obtained of the transversely sectioned occlusal sulci (fissures and grooves) serially, at an interval of about 200 microns, while grinding was performed both from mesial and distal sides. Also with regard to these four teeth, enlarged model charts of the occlusal surfaces were drawn together with the sulci. The sulci were classified into the following patterns :

1) fissures without any contents;
2) grooves;
3) fissures filled up with contents;
4) fissures in which the contents are seen localized in small size.

The sulci in the charts were then partially painted in different colors according to the classification of their cross-sectioned patterns. Moreover, for each tooth, the ratios of the patterns of the cross-sectioned sulci were obtained as against the total number of each pattern of transversely sectioned sulci and also an examination was made as to what distribution could be seen with regard to the four patterns.

All the replicas were obtained from the ground surfaces after each of the cross-sectioned sulci was etched with 0.05 percent hydrochloric acid for 15 seconds. In obtaining the replicas, acetylcellulose film was used and, as for the solvent of acetylcellulose film, methyl acetate was employed.

In conducting the electron microscopic observation, chromium was first shadowed on the replicas and then carbon was evaporated on them.

RESULTS

A. Replicas obtained from the cross-sectioned sulci in the completely impacted teeth.

1) Light microscopic aspects of the contents in the sulci.

The replica findings of the perfectly impacted third molars and first premolar were as follows :

a) fissures in which the contents were filled up (Fig. 1);
b) fissures in which the contents were limited in small size (b and d in Fig. 2; a and b in Fig. 3; b, c, e and f in Fig. 4);
c) fissures in which no contents were observed (c in Fig. 2; d in Fig. 4);
d) grooves (a in Fig. 2; a in Fig. 4).

2) Whole aspects of fissure contents.

The contents that filled the fissures had forms conforming to the fissures (Fig. 1). On the other hand, the contents seen localized in a small amount in the fissures were in varying sizes with a circular (Fig. 3) or irregular form (b in Fig. 2; c in Fig. 4), sometimes seen lined up in a serrated form (d in Fig. 2) and attached to the fissure walls. Some appeared as a bridge between the left and right walls of the fissure (d in Fig. 2; e in Fig. 4).

B. Fissure contents of completely impacted teeth in the ground sections and the replicas as observed light microscopically.

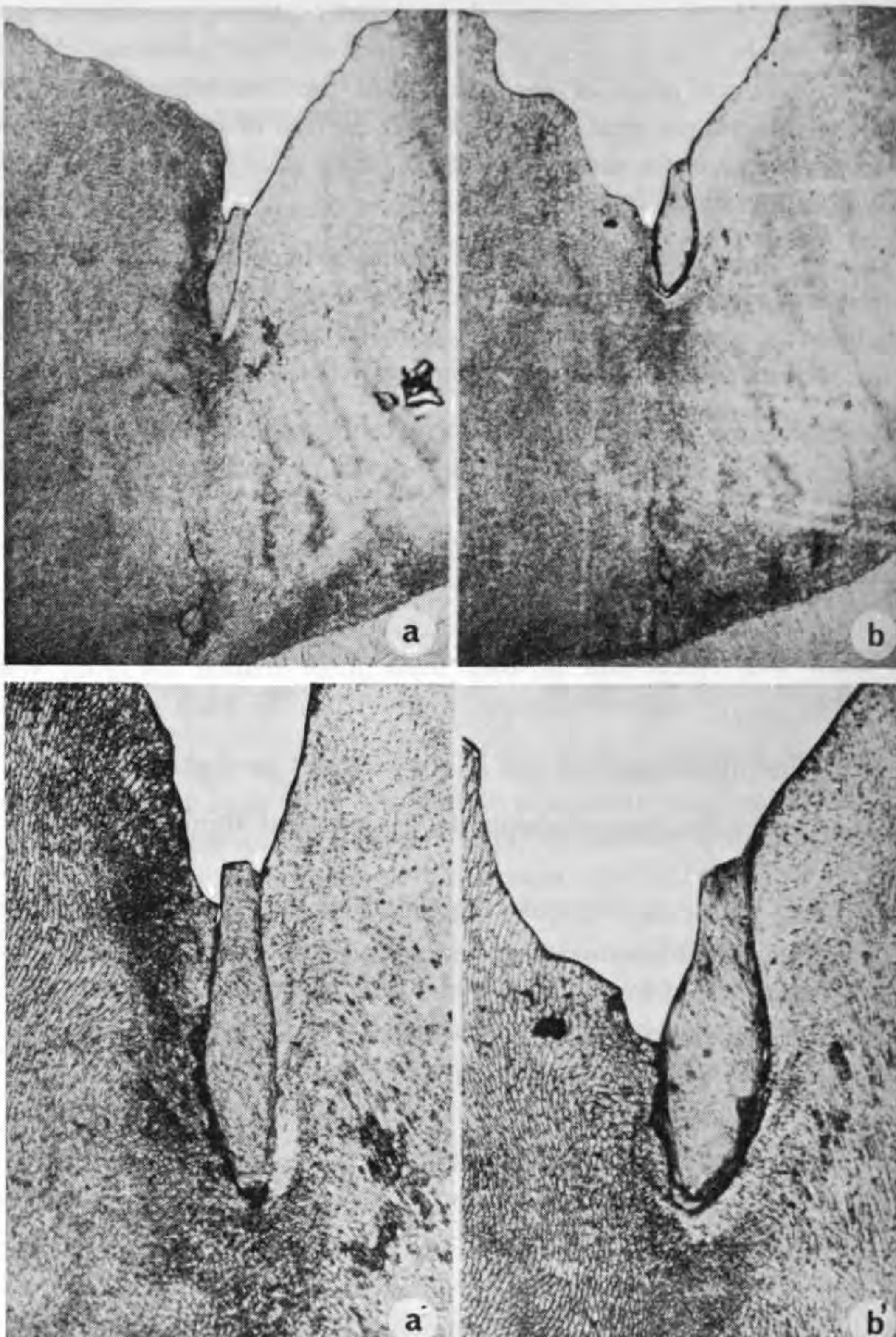


Fig. 1

Light microscopic findings obtained from the replicas of cross-sectioned occlusal sulci in completely impacted lower third molars. The fissures are seen filled up with contents. The minute structure of the contents fairly well resembles that of the enamel. a' is the enlargement of the contents at Photo a and b' the magnification of the contents at Photo b.

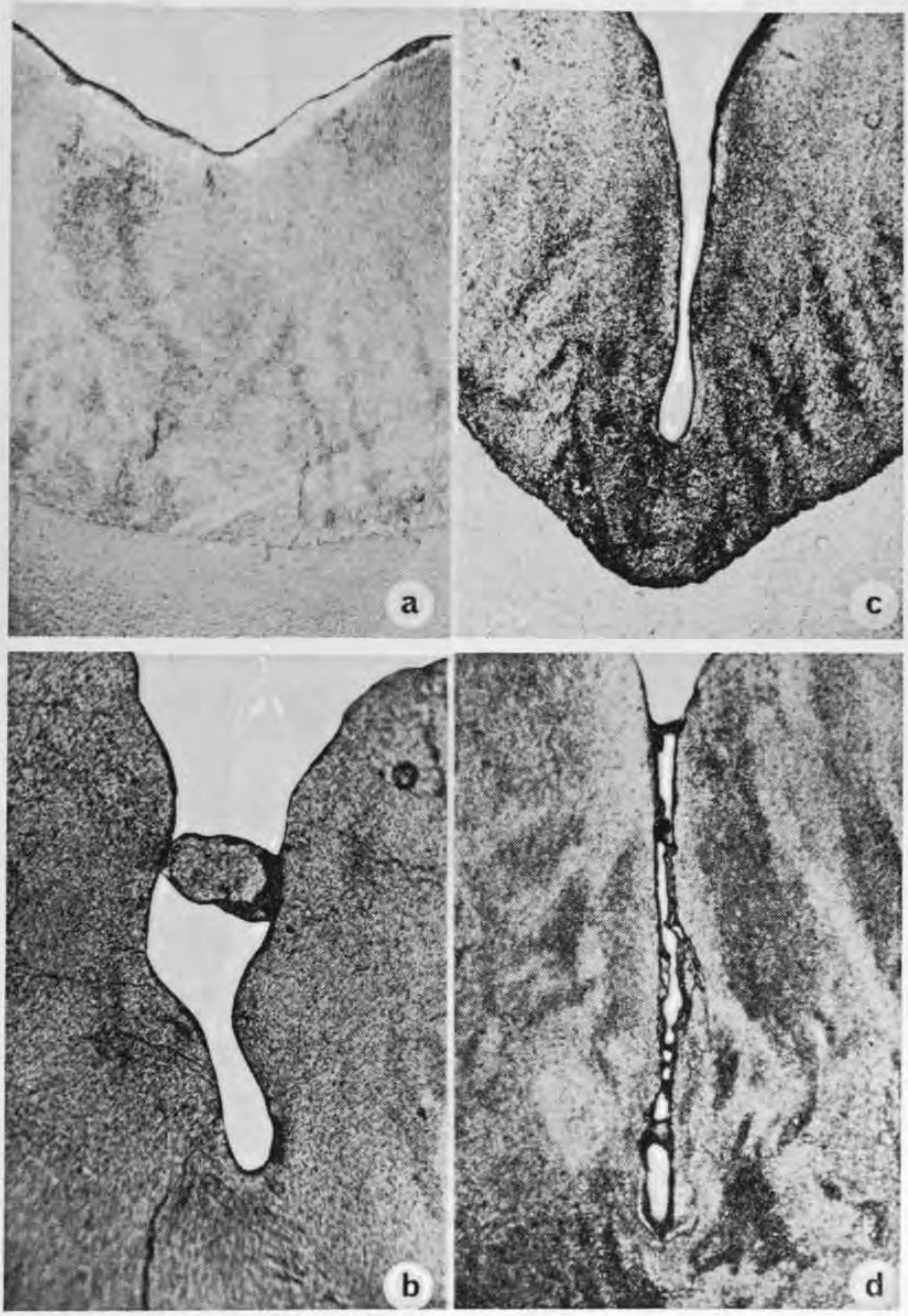


Fig. 2

Light microscopic aspects from the replicas of transversely sectioned occlusal sulci in perfectly embedded lower third molars. a : A groove without any contents or the developmental groove. b : The fissure contents that sticks in manner of a lump between the left and right fissure walls. c : A fissure without any contents. d : Some of the fissure contents are seen between the left and right fissure walls like bridges and the rest of the contents can be seen lined up in a serrated form.

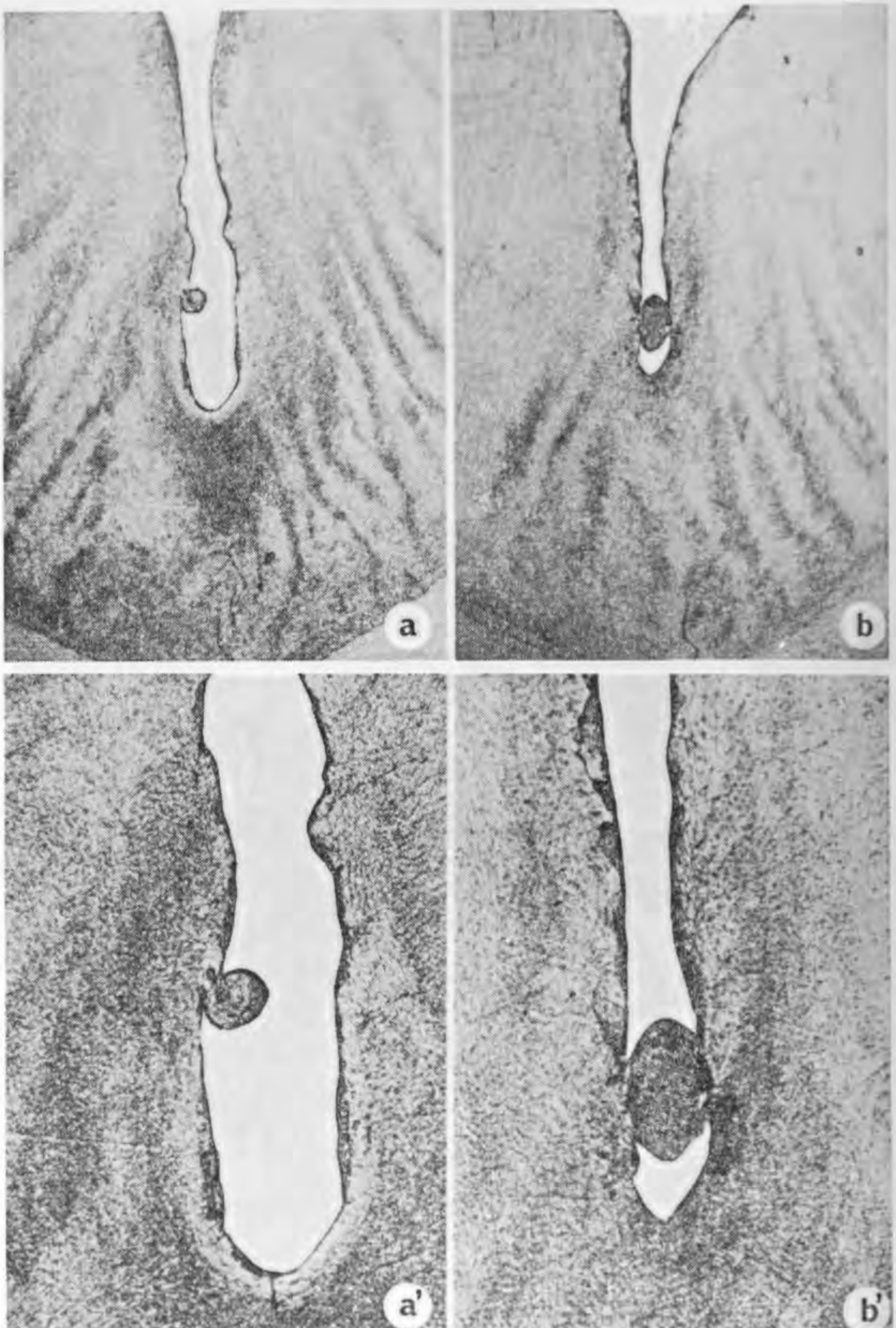
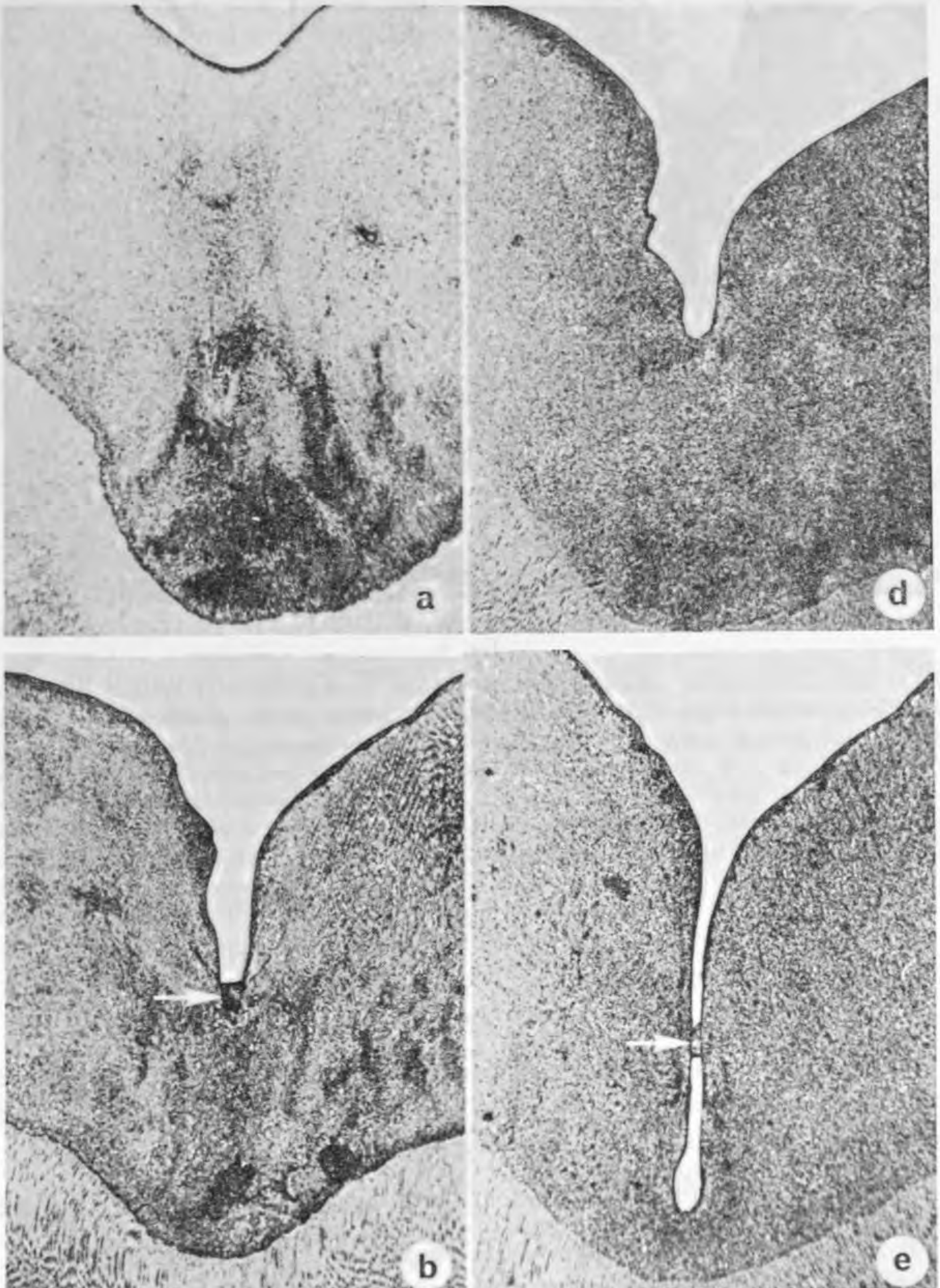


Fig. 3

Light microscopic findings from the replicas of cross-sectioned fissures in perfectly impacted lower third molars. a : In the fissure, it can be seen a small circular piece of contents attached to the fissure wall. Photo a' is the enlarged view of Photo a. b : Deep in the fissure, a small oval-shaped piece of contents is seen attached to the left and right fissure walls. b' is the magnification of Photo b.


a
d
b
e

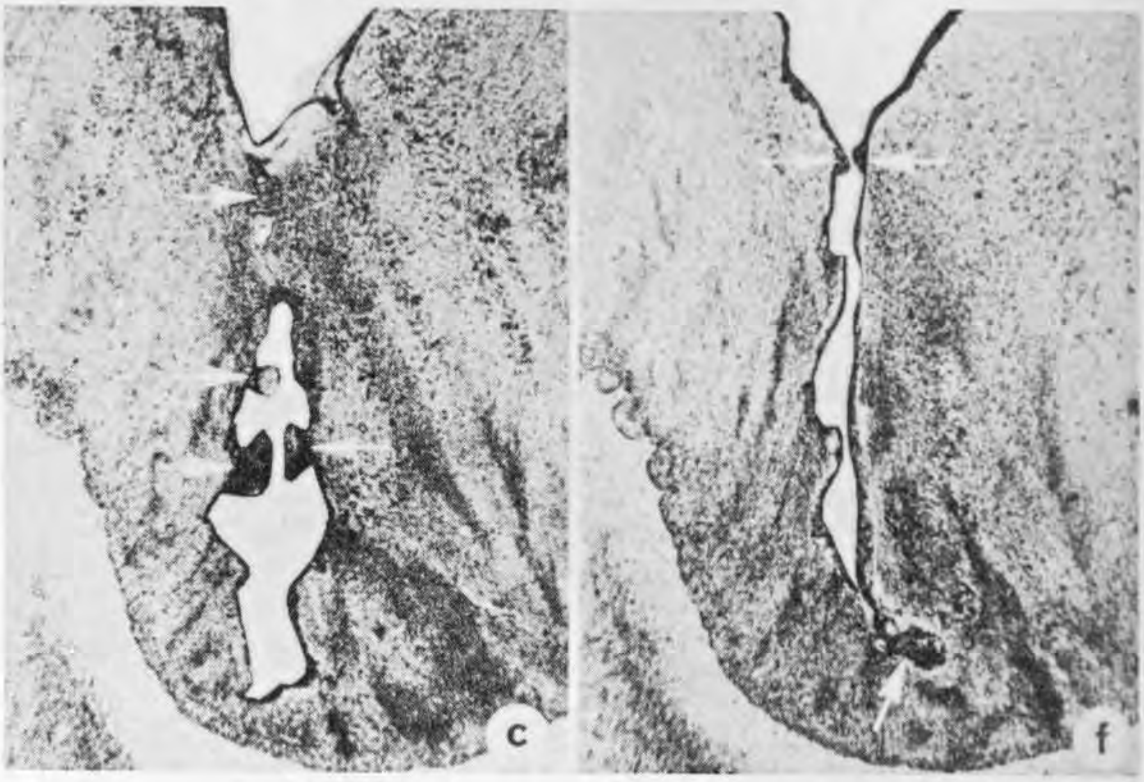


Fig. 4

Light microscopic images obtained from the replicas of cross-sectioned occlusal sulci in a completely impacted upper first premolar. a : A groove or the developmental groove. b : A small piece of contents seen at the bottom of the fissure. c : The entrance to the fissure is closed with the contents below which is a deep and expanded cavity. In the expanded empty space within the fissure, we can see irregular-shaped pieces of contents attached to the fissure wall. d : A somewhat shallow fissure without any contents. e : About half way down the fissure, we can see small amount of contents looking like a bridge between the left and right fissure walls. f : There are seen small pieces of contents at the entrance to the fissure and the bottom of the fissure. Each arrow in the photos indicates pieces of fissure contents.

When the ground sections of completely impacted teeth were stained with hematoxylin and eosin, it was found that the fissure contents showed an affinity to eosin and were invariably dyed red.

The structure of fissure contents was histologically obscure and the contents had an appearance of food debris rich in organic substance.

Meanwhile, the observation made of the replicas showed the structure of fissure contents considerably more in detail than the observation made of the ground sections. However, this method did not enable the observers to go beyond subjective observation about the structure of the fissure contents. That is, the fissure contents sometimes appeared to resemble the enamel contour in the vicinity of the fissure wall (a and b in Fig. 1) or, at other times, seemed similar to food debris.

C. Electron microscopic findings of the fissure contents in completely impacted teeth.

As a result of electron microscopy the fissure contents were found to be hypomineralized enamel (Figs. 5 and 6) and furthermore, this hypomineralized enamel had a distorted structure. For that reason, the enamel rods were partially constricted and narrowed. In many cases rods were seen irregularly arranged and often curved abruptly as indicated by an arrow in Fig. 5. In the hypomineralized enamel, portions that appeared fairly smooth and short of inorganic crystals were often scattered (Fig. 6).

D. Pattern distribution of the cross-sectioned occlusal sulci in the completely impacted teeth.

The pattern classification of the cross-sectioned sulci is as shown in the occlusal model picture of each of the four teeth in Fig. 7.

In these observations, because of grinding both from mesial and distal sides of the teeth, there were not a few distribution areas of sulci running parallel to the ground surfaces of tooth substance in which the cross-sectioned sulcus patterns could not be obtained and remained unclear. Hence, given only these results of examinations, it is not possible to refer to the whole of the distribution area of the occlusal sulci. However, the examination made within the ranges studied suggested :

a) grooves without any contents;
b) fissures (fissured grooves) in which a small amount of contents were observed localized in small size within the fissures were seen distributed in the largest number, which was followed by c);
c) fissures without any contents;
d) fissures filled with contents were seen distributed in the smallest number.

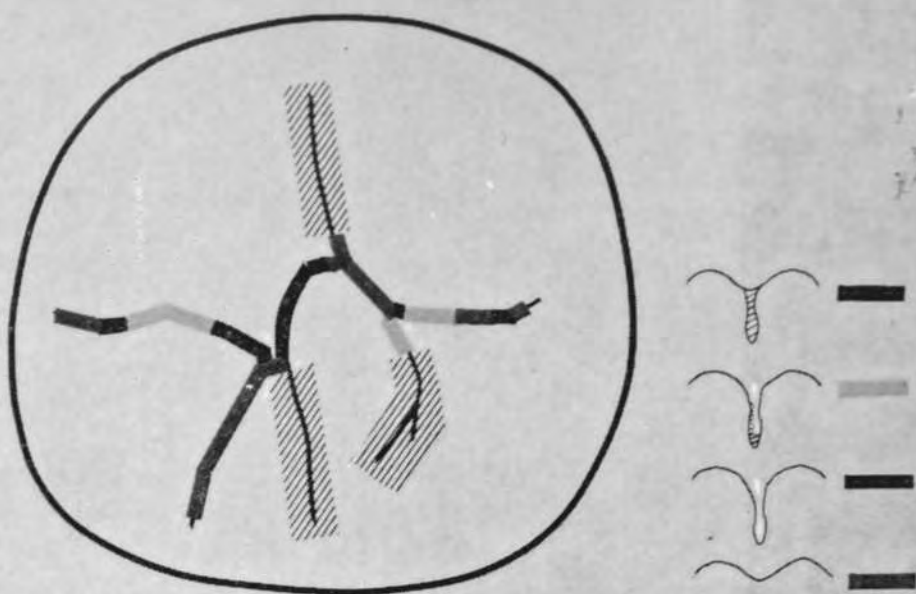
As well, as may be seen in Fig. 7 with regard to the four cross-section patterns of occlusal sulci, no such tendency was seen as that there were fissures and grooves that showed a peculiar type of distribution or that some of the fissures and grooves were found in certain locations in the distribution area. That is, the four different types of cross-sectioned fissures and grooves showed different types of distribution in each tooth.

Fig. 5

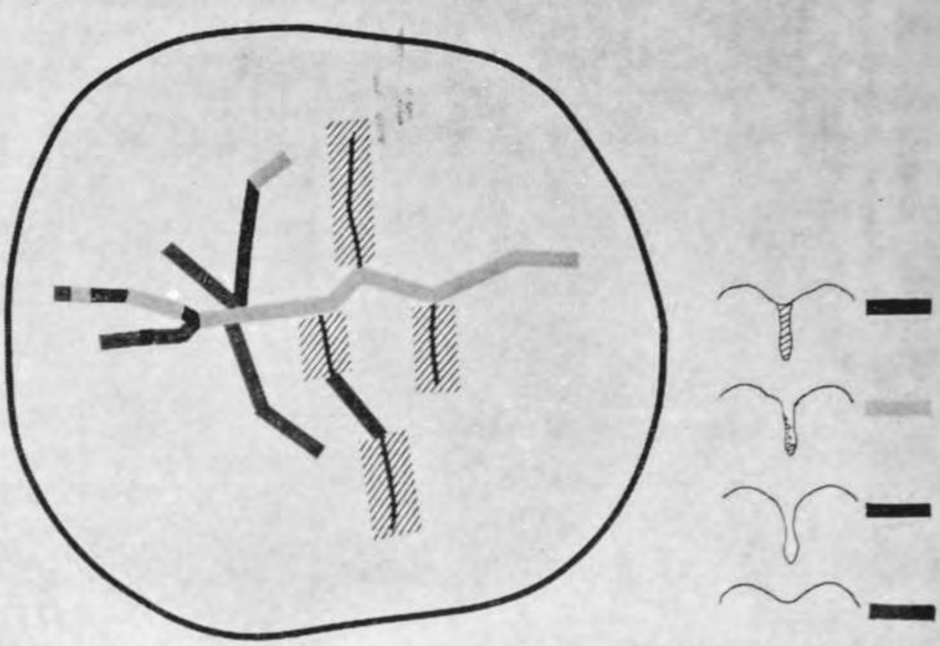
Electron micrograph of the fissure contents in a completely impacted tooth. The contents are made up of hypomineralized enamel and there are seen enamel rods of considerably distorted forms. That is, we can see an enamel rod indicated by an arrow that abruptly curves and it will be noted that the morphology of enamel rods are arranged in an irregular or disorderly manner on the whole. A set of 3 arrows is indicative of a transverse enamel rod, while a dotted line shows the width of an enamel rod.

Fig. 6

The photo exhibits electron microscopically that the fissure contents are made of enamel of poor mineralization. A set of 3 arrows is indicative of a transverse enamel rod.



No. 1



No. 2

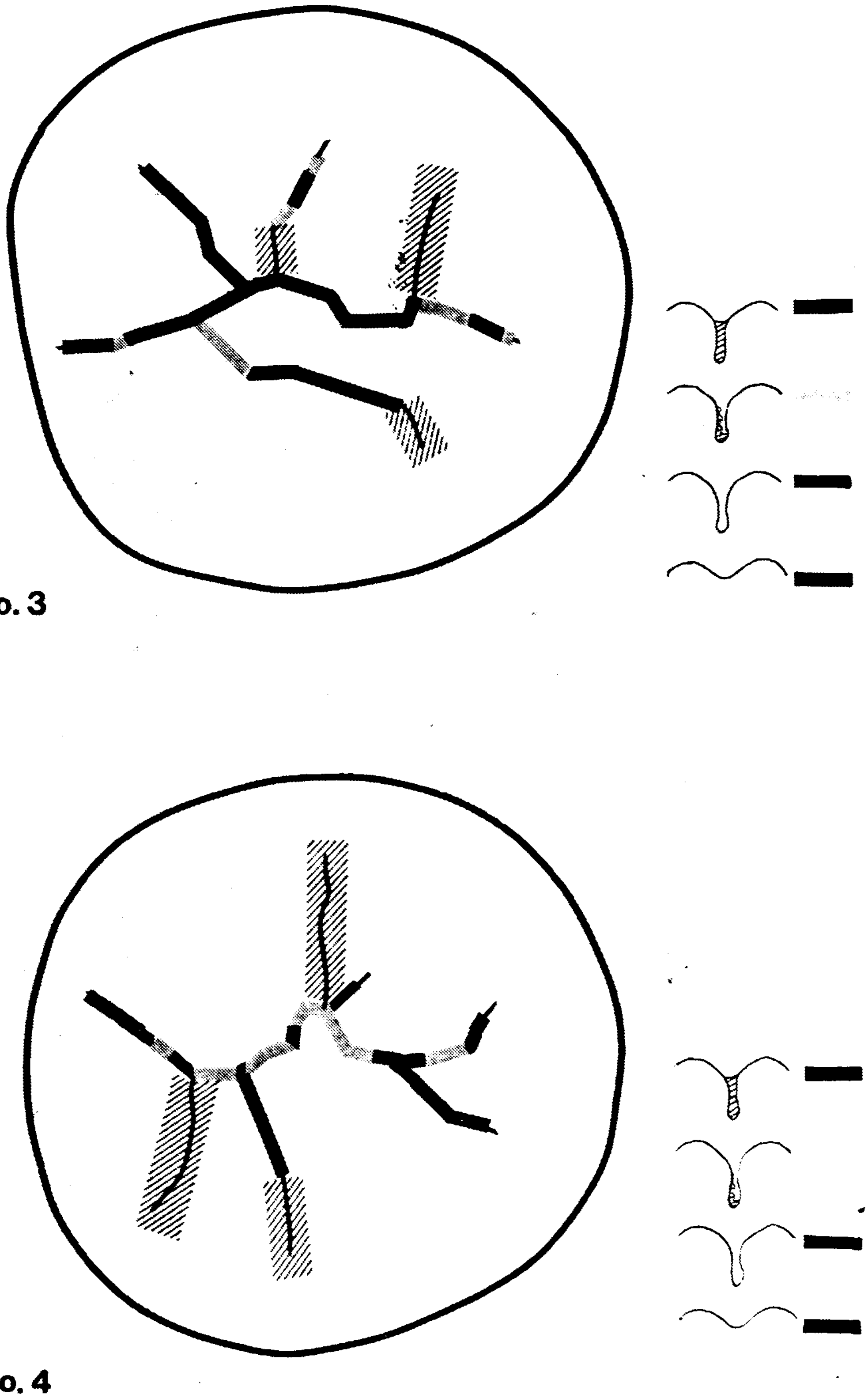


Fig. 7

The distributions classified by patterns of cross-sectioned occlusal sulci in four completely impacted third molars. Widely distributed are the grooves (blue) and the fissures with small amount of contents (green). On the other hand, a relatively limited distribution is seen in the case of the fissures without any contents at all (black) and the fissures filled up with contents (red). The shaded portions show that, because of both from the mesial and distal sides of the teeth, the sulci in those areas were almost parallel to the ground surface and the cross-sections of them could not be obtained at all.

DISCUSSION

Previous authors who have studied the tissue structure of fissure contents have concluded that the fissure contents consist of such foreign bodies [2-6, 8, 11, 15-19] as food debris or calculi. This means that such foreign bodies get in or are deposited in the fissures after the eruption of teeth. As hitherto, most studies have been performed on erupted teeth.

Some authors state that the fissure contents are parts of enamel organ [5] or its residues [8, 12]. However AWAZAWA (1966) [1] differed with this view and reported that the fissure contents of the erupted teeth consisted of hypomineralized enamel as observed electron microscopically. AWAZAWA was followed by GWINNETT (1966) [10] who observed, under a polarizing microscope, that the fissure contents of erupted teeth consisted of enamel of poor mineralization and also by SOBUE and his collaborators (1974) [20] who examined the fissures of unerupted teeth by X-ray crystallography using X-ray microdiffraction method as well as by polariscopy and microradiography, and reported that the fissure contents were composed of hypomineralized enamel.

In this study, histological examinations were made of the fissure contents exclusively in completely impacted teeth, a method not yet studied. As a result, it was found that fissure contents in completely impacted teeth, also consisted of enamel of poor mineralization when observed electron microscopically. The hypomineralized enamel was found to be linked closely with the fissure wall.

As to why the hypomineralized enamel was formed within the fissures, GALIL and GWINNETT (1975) [7] made the following observations. They confirmed the repletion of a part of enamel organ remaining within the fissures of each unerupted tooth after crown formation and found that ameloblasts existed very densely in narrow fissures and lined up in close contact with the fissure wall.

GALIL and GWINNETT also reported that ameloblasts, through mutual pressing, brought about obstruction to the formation of enamel matrix in the course of enamel formation within the fissure. They suggested that, as a result, enamel of poor mineralization was formed within the fissure.

SOBUE and his collaborators (1974) [20] confirmed that fissure contents were made up of enamel of poor mineralization in the case of unerupted tooth after crown formation with irregular enamel rod formation. Also they showed the presence of hydroxyapatite within the fissure contents by means of X-ray microdiffraction and, believing that hydroxyapatite was originally formed within the fissure contents, they confirmed that the fissure contents consisted of hypomineralized enamel.

As to the mechanism by which the hypomineralized enamel was formed in the fissure, SOBUE et al. explained as follows. The fissure contents of an unerupted tooth were located in an environment of deep enamel and therefore it might be supposed that the intake did not easily occur of such elements as Ca and P from the tissue adjacent to the fissure. For this reason, there was a high possibility that it was difficult for the final maturity of mineralization to be brought about to the enamel formed wihin the fissure. Thus SOBUE et al. said that immature enamel would be inevitably formed judging from the viewpoint of the formation of fissure contents and crystallite growth.

Also, according to SOBUE et al., it was difficult to establish that Ca, P, etc. were supplied from the side of the pulp to the enamel within the fissure even after the eruption of teeth, and there was a possibility that the enamel matured by coming into contact with saliva.

SOBUE et al., also, observed that the enamel of the fissure contents of unerupted teeth was of poor mineralization and, moreover, that the running of enamel rods was irregular. This disorder of crystallite formation in the enamel within the fissure was considered as being due to a lot of lattice uniformities in apatite crystallites resulting from excessive packing of the crystallites within the fissure, and due to the subsequent delay in the growth of crystallites.

GLAS (1962) [9] mentioned that the lattice defects of apatite crystallites might be brought about by strain caused by mechanical stress which came from the dense packing of crystallites in the stage of enamel formation, and subsequent delay of the crystallite growth was seen in the direction of a-axes of crystallites.

According to SOBUE et al., with regard to the crystallinity of apatite crystallites in the enamel within the fissure, as compared with the normal enamel, no difference was noticed in the direction of a-axes of crystallites. From this, they said that there would be no further crystallite growth in the direction of c-axes but there was a possibility of crystallite growth being made in the direction of a-axes.

Meanwhile, KATADA et al. (1982) [14], in order to find out the mineralization degree of the enamel within the fissures of erupted tooth, measured its microhardness value which had a value of 1/4.1 - 1/5.5 of that of normal enamel.

In the present study, a measurement of microhardness values of the hypomineralized enamel within the fissure in completely impacted third molars was made using the MVK-D type Vickers microhardness tester manufactured by Akashi Co. Impressions were made with the diamond intender by applying a load of 10 grams (the lightest load) to the hypomineralized enamel which broke into fragments without offering much resistance even by the lightest load and satisfactory results could not be obtained.

According to the report by GALIL and GWINNETT [7], formation of hypomineralized enamel within the fissure seems to begin usually in proportion to the time of tooth eruption. That is, the hypomineralized enamel is formed secondarily inside the fissure after a fairly long pause following the completion of fissure formation in the enamel. Considering these, the hypomineralized enamel may be called the enamel of secondary formation (secondary enamel).

According to AWAZAWA [1], the fissures in erupted teeth are fully filled with hypomineralized enamel. The present study made on completely impacted teeth, however, led somewhat different findings :

1) Empty fissures without hypomineralized enamel were seen in large numbers.
2) Fissures with a small amount of hypomineralized enamel were also seen in large numbers.
3) There were fewer fissures filled with hypomineralized enamel.

Within the scope of this study, it is not clear why there are such differences as mentioned above between the completely impacted teeth and the erupted teeth. Tooth impaction is in itself a pathological state, and it is quite within the bounds of possibility that often wide or small areas of enamel organ remaining within the fissures degenerate due to the long indefinite continuation of tooth impaction.

AWAZAWA [1] pointed out that hypomineralized enamel within the fissures, in view of its tissue property, had a high caries susceptibility. SOBUE et al. [20] also said that enamel within the fissure and the fissure wall, were not only lagging behind in mineralization but also had qualitative faults and therefore could be considered as being high in caries susceptibility.

It is a matter of common knowledge that completely impacted teeth rarely erupt. In such a case, in the teeth (molars and premolars) concerned, there can be seen widely distributed empty fissures and fissures in which a small amount of hypomineralized enamel is localized. The present authors believe that, in such teeth as mentioned above, fissure caries susceptibility is much higher than in normally erupted teeth owing to the outcome of deep invasion of foreign bodies into fissures.

CONCLUSIONS

Having investigated occlusal fissures and their contents in completely impacted teeth by light and electron microscopy, some interesting results have been obtained. That is, light microscopic observation of the cross-sectioned fissures revealed as follows :

a) Some of the fissures were filled with contents.

b) Some had small amount of contents restricted to one or more spots of the fissure walls.

c) Some had no contents and these fissures were quite empty.

The minute structure of fissure contents could not be ascertained by light microscopy and the observations made were considered subjective. When observed electron microscopically, the fissure contents were found to be made up of hypomineralized enamel.

REFERENCES

[1] AWAZAWA, Y. — Electron microscopic study on the hypomineralized enamel areas descending from the floors of occlusal fissures toward the amelo-dentinal junctions. *J. Nihon Univ. Sch. Dent.*, **8** : 33 (1966).

[2] BLACK, G.V. — Descriptive Anatomy of the Human Teeth. 4th ed., Wilmington Dental Mfg. Co., Philadelphia, Glossary pp. 11, 12 (1897).

[3] BÖDECKER, C.F. — A rational means of controlling the evils of incipient dental caries. *Dent. Cosm.*, **71** : 286 (1929).

[4] DIAMOND, M. — Dental Anatomy. A Graphic Presentation of Tooth Forms with an Original Technique for Their Reproduction. Mac-Millan Co., New York, pp. 224, 225, 284, 285 (1933).

[5] FRANK, R.M. — Microscopie électronique de la carie des sillons chez l'homme. *Arch. oral Biol.*, **18** : 9 (1973).

[6] GALIL, K.A., GWINNETT, A.J. — Human tooth fissure contents and their progressive mineralization. *Arch. oral Biol.*, **20** : 559 (1975).

[7] GALIL, K.A., GWINNETT, A.J. — Histology of fissures in human unerupted teeth. *J. dent. Res.*, **54 :** 960 (1975).

[8] GILLINGS, B., BUONOCORE, M. — Thickness of enamel at the base of pits and fissures in human molars and bicuspids. *J. dent. Res.*, **40 :** 119 (1961).

[9] GLAS, J.E. — Studies on the ultrastructure of dental enamel. II. The orientation of the apatite crystallite as deduced from X-ray diffraction. *Arch. oral Biol.*, **7 :** 91 (1962).

[10] GWINNETT, A.J. — Normal enamel. II. Qualitative polarized light study. *J. dent. Res.*, **45 :** 261 (1966).

[11] GWINNETT, A.J., BUONOCORE, M.G. — A scanning electron microscope study of pit and fissure surfaces conditioned for adhesive sealing. *Arch. oral Biol.*, **17 :** 415 (1972).

[12] HODSON, J.J. — A study of some of the developmental, structural and pathological aspects of tubular hypoplasia in human enamel. *Brit. dent. J.*, **89 :** 6 (1950).

[13] HOPEWELL-SMITH, A. — Concerning human enamel : Facts, explanations and applications. *Dent. Cosm.*, **68 :** 639 (1926).

[14] KATADA, N., MISUMI, N., TOBARI, H., AWAZAWA, Y. — A study on the microhardness of hypomineralized enamel hitherto accepted as fissure contents. *Bull. Group. int. Rech. sc. Stomatol. et Odontol.*, **25 :** 45 (1982).

[15] MIWA, M. — A comparison between clinical findings and microscopic examination as regards early caries in pits and fissures. *Shikageppo*, **21 :** 1 (in Japanese) (1941).

[16] NAGANO, T. — Relations between morphology and localization of incipient caries in pits and fissures in molars. *Shikwa-gakuho*, **60 :** 1178 (in Japanese) (1960).

[17] NAKAGAWA, T. — Morphological study of unsusceptible occlusal pits and fissures against dental caries in old premolars. *Jap. J. oral Biol.*, **25 :** 481 (Jap. text with Engl. abstr.) (1983).

[18] OOYA, K. — A scanning electron microscopic study on the differences between newly erupted teeth and old teeth with reference to fissure enamel surfaces and contents. *Bull. Tokyo med. dent. Univ.*, **24 :** 89 (1977).

[19] RÖSE, C. — Instruction in the case of the teeth and mouth. *Dent. Cosm.*, **42 :** 745 (1900).

[20] SOBUE, S., SUZUKI, T., MORIWAKI, Y. — Concerning the crystallization of apatite in fissures and fissure contents in an unerupted second molar. *Jap. J. Pedodont.*, **12 :** *135* (in Japanese) (1974).

RESUME

Nous avons étudié les fissures occlusales et leur contenu au niveau de dents complètement incluses à l'aide du microscope optique et électronique et obtenu quelques résultats intéressants. C'est-à-dire au microscope optique, l'examen des coupes de fissures ont montré :

a) Un certain nombre de fissures étaient comblées.

b) D'autres étaient comblées à certains endroits limités, localisés le long des murs de la fissure.

c) D'autres enfin ne contenaient rien et les fissures étaient pratiquement vides.

La fine structure du contenu des fissures ne pouvait pas être précisée au microscope optique et l'interprétation ne peut qu'être subjective.

Observés au microscope électronique, les dépôts comblant les fissures se sont avérés être de l'émail hypominéralisé.