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DENTAL PULP REACTIONS FOLLOWING THE EXPOSURE OF CORONAL DENTINE IN VIVO

by

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INTRODUCTION

The exposure to the oral environment of dentine in cavities prepared in non-carious, young teeth has been shown to result in marked alterations both in the pulp and in the dentine (*Fish*, 1932; *van Huysen & Gurley*, 1939; *Langeland*, 1957). However, by the exposure of coronal dentine *in vivo* in the form of ground facets, only an increased mineralization in the surface layer of the denuded dentine was observed; and, in addition, a re-establishment of normal staining reactions in the dentine, previously distorted due to the facet preparation, was noted (*Mjör*, 1967a). The reactions of the dental pulp following the *in vivo* exposure of dentine in experimentally prepared facets has not been studied. Considering that cavities allow food retention, it is likely that the reactions in the pulp as well as in the dentine will be different from that seen as a result of the exposure of relatively self-cleansing facets. It was considered to be of interest, therefore, to report the observations made in a study where the effect of the exposure of ground facets on the pulp was evaluated.

MATERIALS AND METHODS

The material previously employed in studies of dentine reactions to the exposure of ground facets (*Mjör*, 1967a) was available. The series to be re-

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ported in the present paper consisted of 33 young, clinically caries free premolars which were to be extracted for orthodontic reasons. Either a buccal or lingual facet was prepared using a diamond wheel and an airturbine with air-water spray. These facets were left exposed to the oral environment without further treatment for periods varying from 3—101 days. Immediately prior to, or just after, the extraction of the teeth, another facet was prepared so that each tooth had both a buccal and a lingual facet.

The routine histologic technique employed in our laboratory was used (Langeland, 1957; Mjör, 1966), and axiobuccolingual, decalcified sections stained in haematoxylin and eosin (HE), toluidine blue (TB), and alcian blue (AB) were studied.

The preparation of the facets *per se* did not result in the aspiration of odontoblast nuclei into the dentinal tubules to any appreciable degree (Mjör, 1967a), and the facets were usually shallow, i.e. in the outer 1/3 of the dentine. The present evaluation of the sections were focused on the predentine, the odontoblast layer and adjacent pulp tissue; especially any signs of local hyperaemia and of haemorrhage or the presence of inflammatory cells in the pulp tissue subjacent to the experimental areas were examined. While evaluating the material, a comparison was made between the pulp/predentine areas corresponding to the dentinal tubules exposed by the two facet preparations in each tooth, as well as to similar unoperated areas. The sections were also examined in the polarizing microscope for the detection of any evidence of haemosiderin crystals (Langeland, 1957).

The sections are from young premolars, and they were all, except that in Fig. 4, stained in haematoxylin and eosin.

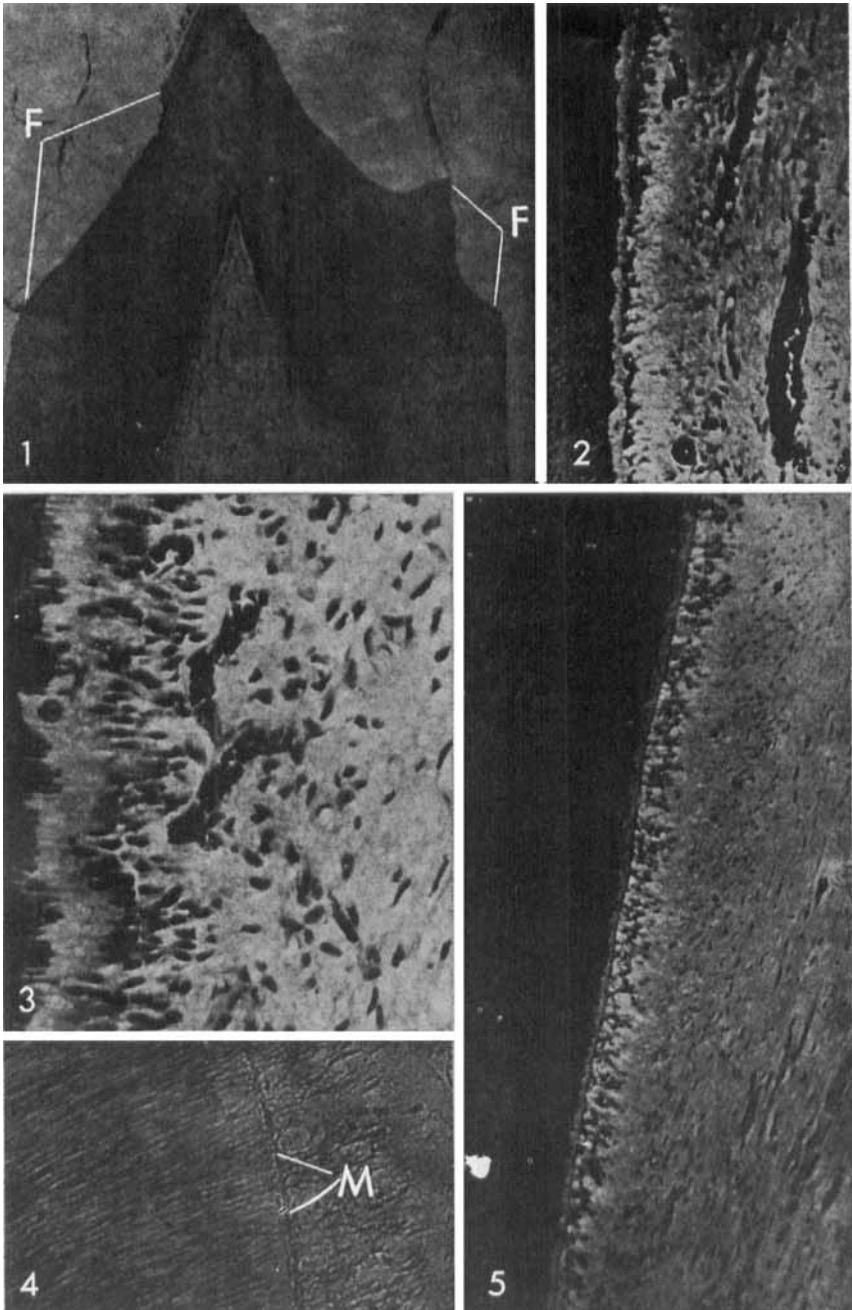
Fig. 1. Coronal portion of a premolar with two facets (F). The lingual facet (right side) was prepared immediately after the tooth was extracted, but prior to fixation. The buccal facet (left side) was prepared 25 days prior to the extraction. $\times 10$.

Fig. 2. Area subjacent to facet prepared 21 days prior to extraction. Slight reduction in the height of the odontoblasts, and possibly a very slight hyperaemia, but no inflammatory cells present. $\times 130$.

Fig. 3. Area subjacent to facet prepared 21 days prior to extraction. Note the presence of a few more connective tissue cells in the layer of Weil than that found normally. $\times 330$.

Fig. 4. Area subjacent to facet prepared 3 days prior to extraction. Note presence of pulp-dentinal membrane (M). Toluidine blue stained section. $\times 220$.

Fig. 5. Dentine and pulp subjacent to facet prepared 98 days prior to extraction. The histologic features are similar to those observed in the normal (unoperated) material. $\times 110$.



OBSERVATIONS

Generally, only minor histologic changes were observed in the pulp and predentine areas corresponding to dentinal tubules from the facets which had been exposed to the oral environment for some time (Figs. 1—5). A separation of the pulp tissue from the predentine was frequently seen subjacent to the facets prepared immediately prior to the extraction of the teeth, but this is primarily considered to be a histologic artefact (*Mjör & Nygaard Östby, 1966*).

No increased secondary dentine formation, nor any apparent changes in the predentine width could be found in the experimental areas; neither could any systematic alterations in the odontoblast layer be registered. Considering that neither brown pigment could be observed in the H-E stained sections nor crystals in the polarizing microscope, it was concluded that no haemorrhage had occurred in the pulp tissue. Furthermore, no accumulations of inflammatory cells could be found in the pulp tissue subjacent to the exposed facets. However, a slight hyperaemia in the areas corresponding to the exposed facets could be observed in most teeth with observation periods less than approximately 30 days (Fig. 2), but in the four teeth with observation periods of 84—101 days, no hyperaemia was found (Fig. 5).

In some specimen, including two of the four with relatively long observation periods, a slight increase in the number of connective tissue cells were observed in the layer of Weil (Fig. 3) which is normally relatively cell free (Figs. 2 and 4).

The TB and AB stained sections did not render any additional information regarding alterations in the pulp and predentine regions. The so-called »pulpodentinal membrane» (*Bradford, 1950*) often appeared distinct (Figs. 4 and 5) but it was not different subjacent to the facets from that seen in unoperated areas. In any case it is likely that such a »membrane» is an artefact due to shrinkage (*Mjör & Shackelford, 1966*), and it has not been demonstrated electronmicroscopically (e.g. *Arwill, 1968; Reith, 1968*).

DISCUSSION

The denudation of coronal dentine and its subsequent exposure to the oral environment was initially considered to be a procedure which might result in fairly marked pulp reactions, particularly in young teeth where the dentinal tubules are not obturated by highly mineralized material. The explanation of the somewhat surprising observations made in the present study, is probably that the surface layer of the dentine exposed to the oral environment fairly quickly becomes hypermineralized (*Mjör, 1967a*). This hyper-

mineralization may prevent ingress of irritating agents from the oral environment. The finding of a fairly rapid re-establishment of normal staining reactions in the dentine following the exposure of facets (*Mjör*, 1967a) also supports this view, because under several other experimental conditions, a similar re-establishment does not occur (*Mjör*, 1967b).

The slight hyperaemia observed in most cases with short observation periods suggests that the pulp reacts to some degree on the experimental procedure. This reaction is, however, apparently resolvable.

The finding of an increased number of cells in the relatively cell free layer of Weil may be of significance, because it has been maintained that this layer is absent (i.e. cells are found in this location) during dentinogenesis and also during increased rates of secondary dentine formation (e.g. *Provenza*, 1964). However, it is apparent that the pulp reaction following the exposure of relatively shallow, self-cleansing facets differs from that found as a result of the exposure of experimentally prepared cavities (*Fish*, 1932; *van Huyen & Gurley*, 1939; *Langeland*, 1957) where for example increased secondary dentine formation was a striking finding.

Numerous reports have been published related to the effect of various operative procedures on the pulp. It has been conclusively shown that certain filling materials and cutting procedures used routinely in dental practise are harmful to the pulp. Several investigators have stressed the importance of the depth of the cavities, i.e. the thickness of the remaining dentine, with regard to the degree of impact on the pulp by various procedures. However, the permeability or the degree of mineralization of the dentine must be of the utmost importance with regard to subsequent changes in the pulp. *Massler* (1967) has suggested that the pulp and the dentine should be considered as one organ. The present findings support this view, and it implies that in studies of reactions to, for example, operative procedures, methods must be employed which allow evaluation of both the organic and the inorganic fractions of the pulp-dentine organ.

SUMMARY

Shallow ground facets reaching the outer 1/3 of the dentine have been prepared buccally and lingually on 33 clinically intact, young premolars. One of these facets on each tooth was exposed to the oral environment for periods varying from 3—101 days, while the other was prepared immediately prior to the extraction of the teeth. The material was evaluated histologically.

The reactions to the exposure of coronal dentine were found to be small and were limited to an initial, localized, slight hyperaemia and an increased number of cells in the layer of Weil. The main reason for the slight reactions was considered to be the hypermineralization of the surface layer of the dentine which has been shown to occur under these experimental conditions.

RÉSUMÉ

RÉACTION DE LA PULPE DENTAIRE APRÈS MISE À DÉCOUVERT DE LA DENTINE CORONAIRE IN VIVO

Des facettes peu profondes, atteignant le tiers superficiel de la dentine, ont été meulées sur la face vestibulaire et sur la face linguale de 33 jeunes prémolaires, intactes à l'examen clinique. Sur chaque dent, une des facettes a été exposée au milieu buccal pendant des périodes variant de 3 à 101 jours, tandis que l'autre facette a été préparée immédiatement avant l'extraction des dents. Une évaluation histologique du matériel a été effectuée.

Il est apparu que la mise à découvert de la dentine coronaire a provoqué des réactions limitées, se bornant à une hyperémie initiale, légère et localisée, et à une augmentation du nombre de cellules dans la couche de Weil. La principale raison de la faiblesse de ces réactions serait l'hyperminéralisation des couches superficielles de la dentine qui a été observée dans ces conditions expérimentales (Mjör, 1967a).

ZUSAMMENFASSUNG

PULPAREAKTIONEN NACH BLOSSLEGEN DES KORONALDENTINS IN VIVO

In 33 jungen, klinisch intakten Premolaren wurden bukkale und linguale Facetten im äusseren Drittel des Koronaldentins präpariert. Die eine Facette der einzelnen Zähne wurde dem Mundhöhlenmilieu in Zeitperioden von 3 bis 101 Tagen ausgesetzt, und die andere wurde unmittelbar vor der Extraktion des Zahnes präpariert.

Die histologische Untersuchung der Zähne ergab, dass die Pulpa auf Blosslegen des Koronaldentins wenig reagiert hatte. Nur eine kleine initiale lokale Hyperämie konnte beobachtet werden, und vielleicht auch eine Vermehrung der Zellen in der Weil'schen Schicht. Es wurde angenommen, dass eine Hypermineralisation der blossgelegten Dentinfläche die Pulpa gegen äussere Einwirkungen geschützt hatte. Es ist früher nachgewiesen, dass eine solche Hypermineralisation unter diesen experimentellen Bedingungen eintritt (Mjör, 1967a).

REFERENCES

- Arwill T.*, 1968: The ultrastructure of the pulpo-dental border zone. In: *Dentine and Pulp: Their Structure and Reactions* (Ed.: N. B. B. Symons). pp. 147—167. Livingstone Ltd., Edinburgh.
- Bradford E. W.*, 1950: An investigation into the structure of the pulpo-dental junction. *Br. dent. J.* 88: 55—58.
- Fish E. W.*, 1932: *An Experimental Investigation of Enamel Dentine and The Dental Pulp.* John Bale, Sons & Danielson, London.
- van Huysen G. & W. B. Gurley*, 1939: Histologic changes in the teeth of dogs following preparation of cavities of various depths and their exposure to oral fluids. *J. Am. dent. Ass.* 26: 87—100.
- Langeland K.*, 1957: Tissue changes in the dental pulp. An experimental histologic study. *Odont. Tidskr.* 65: 239—386.
- Massler M.*, 1967: Pulp reactions to dental caries. *Int. dent. J.* 17: 441—460.
- Mjör I. A.*, 1966: Stainability of decalcified human coronal dentine. *Archs oral Biol.* 11: 1293—1305.
- 1967a: Histologic studies of human coronal dentine following cavity preparations and exposure of ground facets *in vivo*. *Archs oral Biol.* 12: 247—263.
- 1967b: Histologic studies of human coronal dentine following the insertion of various materials in experimentally prepared cavities. *Archs oral Biol.* 12: 441—452.
- Mjör I. A. & B. Nygaard Östby*, 1966: Experimental investigations on the effect of Leder-mix on normal pulps. *J. oral Therap. Pharmacol.* 2: 367—375.
- Mjör I. A. & J. M. Shackelford*, 1966: Microradiography of human pulp tissue and decalcified coronal dentine. *Archs oral Biol.* 11: 1307—1316.
- Provenza D. V.*, 1964: *Oral Histology. Inheritance and Development.* P. 265. J. B. Lippincott, Philadelphia.
- Reith E. J.*, 1968: Ultrastructural aspects of dentinogenesis. In: *Dentine and Pulp: Their Structure and Reactions* (Ed.; N. B. B. Symons), pp. 19—41. Livingstone Ltd., Edinburgh.

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